Swifterbant stones

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The Neolithic Stone and Flint Industry at Swifterbant (the Netherlands): from stone typology and flint technology to site function

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Swifterbant Stones

The Neolithic Stone and Flint Industry at Swifterbant (the Netherlands): from stone typology and flint technology to site function

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Preface

This is a book on stones; all sorts of prehistoric stones. This work is to be considered as a detailed inventory or book of reference, primarily written for the flint and stone specialists among us. We are a small club of experts, often regarded as bizarre and maybe even crazy people interested in tedious things such as endless typological variations, never-ending technological attributes, and continuing raw material determinations to name but a few. As a detailed report of all these aspects would only reach a rather select club of readers, and admittedly could be rather incomprehensive and dry to read, a wider audience was attempted to be reached by moving the main two chapters to the catalogue. There they are held in reserve and ready to be consulted for the brave and happy few who dare to venture in this realm. Syntheses of the two chapters are incorporated in the body text of this book (chapters 4 and 5).

Ventures to more general topics and research aspects were made, but in an introductive manner. Other researchers have addressed these topics with more depth dedicating papers, books, journals, and even whole careers to them. I lightly touched upon these matters, as they should indeed be addressed in this work, but did not go into detail. My focus, and detail, clearly lies with the stones and all their glorious aspects.

Introduction

Although history is in the past, it is always on the move. Fifty years ago nobody knew of the existence of the Swifterbant culture. Yet today, the Swifterbant people are fully part of our prehistory. Even though the Swifterbant site itself has been under investigation for twenty years (1961-1982), and is recently the centre of renewed investigation, some of the archaeological remains are not analysed as they should be. This research will give this material the attention it needs and the place where it belongs; a place in history.

This book focuses on the internal variation of the Swifterbant type site, in this research also referred to as the Swifterbant cluster, and its place within the larger setting of the Swifterbant culture. For too long, the different occupation areas at Swifterbant, i.e. levee sites and river dune sites, have been regarded separately, while in reality they formed an interlinked chain of suitable habitation localities within the site territory. Based on the lithic information, their general characteristics and their distinguishing features are presented in this research. These findings lead to a better insight in the internal dynamics of the different occupation areas themselves but also of the different occupation phases within the Swifterbant type site. Now this wealth of information is finally available, it enables more detailed research into the internal dynamics of the Swifterbant culture as a whole and certainly into its relationship to other, temporary cultures.

In this respect, certain aspects of these internal dynamics and the intercultural relations are thus somewhat under-investigated in the current research and may even seem underappreciated. The long term evolution of the Swifterbant culture, from its origin in the Late Mesolithic to its demise in the Middle Neolithic, is indeed not to be neglected, but will not be the main focus of this thesis. The same applies to the development of the Hazendonk Group or the transition to the Funnel Beaker culture. The long term chronological and cultural dynamics are fascinating but should be regarded from a distance. If they were to be analysed in the same detail as applied in this lithic study, it would take a life's work. Even more, such an overview can only be performed when the internal dynamics of the Swifterbant culture are known, a task hopefully succeeded here.

For the same reason, less attention was paid to the Mesolithic occupation phases, both within the Swifterbant site and outside. Indeed, because the river dune sites at Swifterbant have a long occupation history, and are therefore a mixture from different phases, the focus of this research on the relatively short-lived levee sites is justified.

The structure of this Ph.D. was rather self-evident from the beginning of this research. The succession of the chapters, and the internal order of certain topics, was not. The main problem was, when one wants to write a book on a certain subject, it is that the subject needs to be defined first. Yet, if little is known on the subject, how can we define? Luckily, thirty years of investigation on the Swifterbant culture led to a certain amount of general knowledge on the subject. At the same time, the research at the Swifterbant site itself showed large lacunas. The original idea to first present the research history in order to show the existing lacunas was discarded as being too confusing. Therefore a basic and straightforward division and arrangement was chosen.

Chapter 1 is an introduction to this research as it presents the research in general. The point of origin or central problem is sketched, as is the research context. Then the research aims and the research questions are addressed. Even though the central problem of this book generates from the research history at the Swifterbant site itself, the overview of the research conducted at the different sites in the Swifterbant area is presented in chapter 2.

Chapter 2 provides general information on the Swifterbant culture and also on the Swifterbant type site. Cultural definitions and chronological divisions are given whereas a short history on the early years of the Swifterbant culture and research, as to how it came about, is also presented. Then the research history of the site is addressed. The old and the new research will be used as a basis on which to build my story. Therefore, chapter 2 reveals little or no specific research results on the flint and stone artefacts from the New Swifterbant Project. Instead, it gives a detailed overview of the research conducted at the sites of the Swifterbant cluster.

Readers acquainted with the general aspects of the Swifterbant research and culture in general can begin their journey from chapter 3 onwards. Here the discussion on the analysis conducted in this Ph.D. starts; it addresses the methodology and the research limitations encountered during the analyses.

The centre of the book presents the centre of the research; more specifically chapter 4 focuses on the stone artefacts, whereas chapter 5 presents the flint artefacts. This is a clear-cut analysis without much comparison to other sites. A detailed version of both chapters is given in the catalogue. In short, chapters 4 and 5 provide an enumeration and general description of the artefact types and numbers retrieved from the different sites of the Swifterbant cluster.

After the presentation of the analysed stone and flint artefacts in chapter 4 and 5, chapter 6 brings the information together; both inter-site and intra-site interpretations and comparisons between the different sites of the Swifterbant cluster are given. The second part of chapter 6 focuses on all Swifterbant sites that are relevant to this study. They will be presented briefly and their flint and stone artefacts will be discussed. Afterwards, all aspects of the different Swifterbant sites will be brought together providing a chronological review by topic. The chronological setting of the Swifterbant type site within the development of the Swifterbant culture in general is discussed, all leading to an overview of 1600 years of lithic evolution.

Finally, chapter 7 presents a personal insight in the Neolithic occupation phase at Swifterbant.

Chapter 1

The general setting of the research

1.1 Point of origin

1.1.1 Introduction

When the research history (see sections 2.5 and 2.6) of the Swifterbant site is run through, several lacunas in the overall analysis, and general knowledge, of the flint and other stone artefacts are painfully obvious. These lacunas are the result of diverse factors and circumstances. One of the major issues is the limited interest and the lack of research tradition in the analysis of stone artefacts other than flint. The limited time given to flint analysis is another main issue. The third lacuna is the focus of each researcher on their own research subject leading to an absence of a general overview and comparison. These central problems need to be addressed and resolved, a matter settled here.

1.1.2 Research context

This research[1] started under the initiative of D. Raemaekers. As he was already working on the Swifterbant pottery when he joined the staff at the University of Groningen (Groningen Institute of Archaeology) as the new professor of Prehistory and Protohistory of Northwestern Europe, a new opportunity presented itself. With this new position, the prospect of investigating, and preferably even answering, important research questions on the neolithisation process came within reach. Old lacunas could be filled but would raise new questions nearly immediately.

Therefore, D. Raemaekers started the New Swifterbant Project in 2004 (Raemaekers et al. 2005). The 2003 inventory revealed obvious and less obvious lacunas in the research performed so far and cleared the road for a new initiative. The New Swifterbant Project has two main research goals. The first goal is to gain better insight in the past, more precisely to look for additional information on the activities performed at the sites. This entails not only the testing of new excavation techniques but also the implementation of new archaeo-zoological and archaeo-botanical research in order to reconstruct the landscape and analyse its dynamics in the near surroundings of the site. These dynamics may have had a certain influence on the conditions of habitation and the choice of suitable occupation areas. As a wide variety of suitable areas or sites was available their inter-site relation is of primary importance to the new research project as well. The second goal is to establish whether current protective measures are sufficient enough to preserve the sites for future generations and researchers.

1.1.3 Research motivations

The most obvious reason for starting this specific research project was the absence of detailed information or research on the lithic artefacts of the Swifterbant cluster. Some of the flint material was analysed by Deckers (1979, 1982), and later a small sample was analysed by Raemaekers (1999: 35-41), still all this was rather limited compared to the massive number of flint artefacts collected in the past. For the stone material the state of affairs was even worse. Only the artefacts recognised as tools in the field, during the excavations, which were considered special enough, were studied and briefly mentioned in a publication (e.g. de Roever 1976, Van der Waals 1977). The exception is the short description in the excavation report by Price (1981). Yet, no systematic and extensive research was ever conducted, not on the flint artefacts, and definitely not on the stone artefacts. One of the largest lacunas, and major obstructions in this research, was the total lack of knowledge of the exact number of lithic artefacts ever excavated. The number of finds boxes was known, but nobody ever expected that these would hold so many artefacts.

A second lacuna is the absence of intra-site or inter-site analysis. As most articles are preliminary reports, these are just a description of the encountered material of a specific excavation, thus per site. Some final reports were published, on skeletal remains (Meiklejohn & Constandse-Westermann 1978), on seeds and fruits from site S3 (Van Zeist & Palfenier-Vegter 1981), on animal bones of site S3 (Zeiler 1987, 1997), on the excavation of trenches S21-S24 (Price 1981), on the ceramics (de Roever 1979, 2004), and on a selection of the flint material of sites S2, S4 and S51 combined with trenches S11-S13 and S21-S23 (Deckers 1979, 1982). Along with the publication of Raemaekers (1999) the latter is the only inter-site analysis on flint conducted on the sites of the Swifterbant cluster. The comparison of lithic material of these sites with with material from other Swifterbant sites was never systematically carried out. Again, some isolated statements in Raemaekers (1999) occur but these could never be detailed, as the available material and data of the Swifterbant cluster sites was never fully analysed nor published. On the other hand, references to the Swifterbant site in articles on the Swifterbant culture as a whole were always limited to the

1 The stone and flint artefacts were analysed between September 2004 and December 2008. The first draft of the manuscript was written in 2009, corrections were made in 2012.

same restricted dataset. Therefore, this research project is vital to break through this long lived vicious circle of referring to the same limited dataset and to take the step from site specific research to regional research.

As the lithic material had never been analysed thoroughly, it could not be compared to the other find categories at the site, meaning that there was never a functional interpretation of any of them. Moreover, none of the material of the different find categories was ever compared to that of other find categories, not on the same site or on another site for that matter. The Swifterbant Contributions strove to answer several questions such as the reconstruction of the environment, local cultivation, the subsistence strategy and the settlement pattern. The preliminary use-wear analysis of flint artefacts by Bienenfeld (1985) revealed the presence of a diverse range of daily activities. Yet, the function of each site individually and in relation to the other sites within the Swifterbant cluster was never resolved in detail as all functions, such as plant and hide processing, butchering, and bone, antler, and wood working, occurred at all sites (see section 5.5). The presence of the many different find categories at the sites that point to prolonged settlement-related activities was seen as distinct from short-term occupations and special activity sites (Bienenfeld 1985). Combined with the year round occupation, or periodic visits whole year round, established by the presence of both summer and winter animals, researchers inferred the continuous, or at least prolonged, occupation of the Swifterbant cluster sites (Zeiler 1997, de Roever 2004). Ever since nobody sought for the precise function of any of them as it was established they were all settlement sites.

1.2 Research focus and components

The research is first and foremost based on the analysis of the totality of flint and stone artefacts from the different sites at Swifterbant. In order to answer the research questions, several tasks needed to be fulfilled and analyses needed to be performed. The latter are typological analysis, technological attribute analysis, raw material analysis, spatial analysis, use-wear analysis, residue analysis, and refit analysis.

In order to decide how to approach almost all of these analyses an informed study needed to be made on the artefact assemblages. Therefore, a thorough investigation of all the flint and stone artefacts was necessary to create an extensive and detailed inventory. The fact is that at the start of the research the material to be studied covered an unknown number of artefacts. Even at the end of the final year of research new material was uncovered in the depot. One cannot start to consider any sort of analysis if there is no idea of how many artefacts and especially what type of artefacts there are. Stock-taking was of vital importance for this study and formed therefore a considerable part of the research time. This is true for both the flint and stone material. It turned out that the material was much more substantial than initially thought.

Although the point of focus is a rather classic typological analysis, the other facets of the research[2] were not neglected. All aspects of the investigation have been conducted, even if it is not as extensive as the typological analysis. Further elaboration of that kind on the other facets of the research would also be desirable but was precluded by the time and resources available for this study.

After the different aspects of this study are combined the research results will be interpreted per site and in relation to other, attainable information sources such as data from different find categories, features, radiocarbon dates, and spatial patterning. These data will in their turn be interpreted in intra-site and inter-site relations. Finally the whole set will be compared to the research results of other Swifterbant sites in the Netherlands and Belgium in order to situate the Swifterbant type site within the history and evolution of the culture.

1.3 Research questions

With the construction of this research within the scope of the New Swifterbant Project several research question were put forward while creating the Ph.D. proposal. These research questions were taken up by the author and adjusted or elaborated where necessary. The eventual questions are:

- Which production processes can be attested. Is it possible to reconstruct the core reduction sequences? Which operational chains were used?
- Which artefact and tool types are present? Which blanks were selected for which tool types and what is their relation to the other debitage material?
- How large is the variability of the raw materials used and what are the possible procurement areas? Which patterns are discernible in the selection and use of the different raw materials? Is the raw material in any way responsible for the production techniques applied?
- Which activities can be attested by use-wear analysis? Can residue analysis confirm the determined tool type? Are these activities the same on all sites?
- Which spatial patterns are visible within the flint and stone assemblages? Can any special activity sites be located?

2 Other aspects are technological attribute analysis, raw material analysis, spatial analysis, use-wear analysis, and residue analysis.

- Which are the relations between the defined patterns of the flint and stone material and those of the other finds categories?
- What variation is there in the sites characteristic of the Swifterbant area and how might these be interpreted?
- Which similarities and differences are there between the sites at Swifterbant and other sites of the Swifterbant culture and how might these be interpreted?

In order to answer these questions, a whole series of inquiries and analyses have been conducted. Most analyses could be performed by the author. These included the typological analysis, the technological attribute analysis, the raw material analysis, and the spatial analysis of the flint and stone artefacts. The use-wear analyses of the flint material were conducted by two teams. The first team is the Laboratory of Artefact Studies of the Leiden University under the direction and cooperation of Annelou van Gijn, and comprises Channah Nieuwenhuis, Annemieke Verbaas, and Karsten Wentink. The second team, from the Groningen Institute of Archaeology (University of Groningen) consists of Inger Woltinge and Dick Stapert. The use-wear analysis of the stone material and the phytolith analysis were conducted by Annemieke Verbaas and Channah Nieuwenhuis respectively. A pilot study on refitting was performed by Bettine van Klinken within the framework of a Master project at the Groningen Institute of Archaeology.

Finally, the material needed to be illustrated. This was done in a corpus or catalogue, and not in a more common and simple illustrative manner, in order to exemplify the material to the fullest extent and make a reference work for future research and comparative purposes. The illustrations were mostly freshly drawn by the technical staff of the Groningen Institute of Archaeology and partly copied from old publications. The stone artefacts were drawn by Siebe Boersma while the flint artefacts were drawn by Miriam Los-Weijns.

Chapter 2

The Swifterbant culture and the Swifterbant site

2.1 The definition of the Swifterbant culture

As the Swifterbant culture has been discovered and defined in the past decades, it is only the details that are open to debate. Most researchers are in agreement that the Swifterbant culture forms the start of the neolithisation process in the Pleistocene coversand regions and adjoining Holocene areas between the rivers Scheldt and Elbe, an area encompassing larger parts of the Netherlands and neighbouring parts of Belgium and Germany (Raemaekers 1999). They are also in agreement that one of the most distinctive features, if not the most typical one, is the Swifterbant pottery itself. Aspects on which researchers are debating are the beginning and end date, and the internal chronological division. This is, however, largely the result of continuous research and new discoveries.

After the introduction of the name and the initial description of the Swifterbant culture, two definitions came into circulation[1]. The first was put forward by Hogestijn (1990) who divided the Swifterbant culture into two phases: a Dronten phase (5400 – 5100 BP or 4300 – 4000 cal BC) and a Nagele phase (5000 – 4500 BP or 3900 – 3400 cal BC). The phases were named after the region where a concentration of known Swifterbant sites from that period occurred. The revised definition proposed by Hogestijn (Hogestijn et al. 1995), based on new evidence, included an early phase before the Dronten phase that now became the middle phase. Thus, there was an early phase with predominantly grit tempered pottery (5900 – 5600/5500 BP), a middle phase with predominantly organic tempered pottery (5600/5500 – 5300/5100 BP), and a late phase again with predominantly grit tempered pottery (5300/5100 BP – 4800/4700 BP) (Hogestijn et al. 1995).

The second definition, proposed by Raemaekers (1999), was based on even more information from new excavations. His tripartite division also contained an early phase (6000 – 5700 BP or 4900 – 4600 cal BC), a middle phase (5700 – 5000/4900 BP or 4600 – 3900/3800 cal BC), and a late phase (5000/4900 – 4400 BP or 3900/3800 – 3400 cal BC). The evolutionary differences in pottery technique were also the main criterion on which the division was based. Nowadays, the start of the Swifterbant culture is even pushed back to 6100 BP or 5000 cal BC (Raemaekers 2005).

It is the definition by Raemaekers that will be used in this research. Whether the middle phase begins or ends on this or that date cannot be concluded with the precision of hundred or two hundred years from the lithic information we have at this time and therefore is not deemed relevant for this particular research.

Based on new pottery research Raemaekers (2003/2004) is inclined to divide the Swifterbant area, between the rivers Scheldt and Elbe, into three cultural spheres[2]. As it turns out, the current state of research also indicates a different time of ending per region. These three spheres are related to the river basins in which the different Swifterbant sites are located. In the north the river basins of the IJssel/Vecht/Eem form one sphere expressed in the pottery by the presesence of pointed bases, the importance of rim and shoulder decoration, the occurrence of lugs, and the continuous dominant use of grit temper (ibid: 30). The pottery of the Rhine/Meuse river basins is characterised by the early start and importance of wall (surface covering) decoration, the absence of pointed bases and lugs, and the continuous dominant use of plant temper (ibid: 33). The third and most southern group, located in the Scheldt basin, sets itself apart by the presence of rim perforations, the near absence of wall decoration, and the dominant use of grog temper (Bats et al. 2003, Crombé et al. 2002, 2004).

Additionally, differences in the flint material have also been observed, starting in the Middle Swifterbant Phase. The IJssel/Vecht/Eem group is at that time characterised by a domination of trapezes whereas the Rhine/Meuse group, depicting drop or leaf shaped points, has no trapezes at all. Leaf shaped points are not totally unknown in the IJssel/Vecht/Eem group, but their association to the Swifterbant culture on these sites is far from certain (see sites Schokkerhaven, Schokland, Hüde I) (Raemaekers 1999: 111, 2001: 117).

Finally, it appears that the Swifterbant culture was gradually replaced by other cultures advancing from the south to the north. The Michelsberg culture replaced the Swifterbant culture in the Scheldt basin at about

1 The division into four phases used by Louwe Kooijmans (2005), based on the Ph.D. of Ten Anscher (2012), is not widespread and will therefore not be discussed.

2 This difference was already recognised and expressed as a Northern Group and a Southern Group (see Raemaekers 1999).

4000 cal BC (Crombé et al. 2002). In the Rhine/Meuse area the Hazendonk Group replaces Swifterbant around 3800 cal BC, whereas the TRB Westgroup is introduced in the IJssel/Vecht/Eem system at 3400 – 3300 cal BC (Raemaekers 2003/2004: 29).

2.2 The wider chronological and cultural setting

The evolution of the Swifterbant culture from a ceramic Mesolithic to a Neolithic culture is set against the background of the evolution of Linear Bandceramic culture, through Rössen to the Michelsberg culture. Raemaekers (1999: 181-182) sees this evolution as a trajectory of change in three major steps. The people of the Linear Bandceramic culture (5300 – 4900 cal BC) pave the way and establish initial contact with the Mesolithic communities. The second stage is formed by the Rössen culture (4600 – 4300 cal BC) in which contacts are consolidated, whereas during the third phase, the Michelsberg culture (4400 – 3500 cal BC), the cultural differences between the traditional Mesolithic and innovative Neolithic communities are corroborated.

The chronological and cultural setting sketched here and below provides no more than a general time frame. It is not the ambition of this research to elaborate on the origin of these cultures or their mutual chronology and the influence they might have had on each other.[3]

2.2.1 Late Mesolithic / Early Neolithic A or the Mesolithic versus the LBK (c. 6500 – 4900 cal BC)

The initial neolithisation of the Netherlands starts with the Linear Bandceramic culture (LBK) (5300 – 4900 cal BC)[4] on the loess soils; a culture characterised by a fully sedentary way of life based on agriculture and animal husbandry. In this period outside the loess areas, Mesolithic life continues. In addition, in the whole of Europe a thin spread of LBK material can be found outside the loess areas in non-settlement contexts (De Grooth 2005: 284). LBK pottery, flint points and stone adzes are often found in association with Late Mesolithic flint assemblages, presumably indicating contact and exchange of food, all sorts of products and possibly even labour between the two cultural groups (Raemaekers 1999).

Furthermore, potsherds of a morphology and technique different from that of the LBK material can be found in- and outside LBK settlements. These types of pottery are known as La Hoguette (Jeunesse 1986, 1987, Jeunesse et al. 1991, Lüning et al. 1989), Limburg (Modderman 1970, Constantin 1985, Van Berg 1990), and Begleitkeramiek (Jeunesse 1994, Brounen 1999).

2.2.2 Early Neolithic B / first half Middle Neolithic A or the Early and Middle Swifterbant versus Grossgartach, Rössen, and Bischeim (c. 4900 – 3900 cal BC)

The LBK was replaced in the Netherlands, presumably after a hiatus of some hundred years, by the Rössen culture (4600 – 4300 cal BC)[5]. Rössen itself developed from Grossgartach (5000 – 4700 cal BC) and Planig-Friedberg (4700 – 4600 cal BC) (Dohrn-Ihmig 1983, Spatz 1996) and is followed by Bischeim (4300 – 4200 cal BC)[6].

When the communities in the higher loam and loess areas were changing from one fully sedentary and agrarian culture to another, the coastal and sandy areas of the Low Countries were economically speaking still Mesolithic. During this period Rössen cultural goods spread throughout nearly the whole of the Netherlands. This is much farther than the 70 km contact radius of the LBK culture, implying engagement and exchange relations on a larger scale (Raemaekers 1999). Eventually, the Mesolithic people of the sandy areas gradually incorporated Neolithic trademarks into their native traditions. The earliest evidence of pottery is dated to 5000 cal BC. Later, animal husbandry was introduced step by step, with cattle and sheep/goat at 4600 BC and pig around 4200 BC (Raemaekers 2003: 742; Raemaekers 2005: 261, 277). The first cereal remains are also dated to 4200 BC (Raemaekers 2005: 277, Cappers & Raemaekers 2008). It is clear that the Swifterbant people chose to supplement their Mesolithic lifestyle of hunting, fishing, fowling, and gathering with those aspects of the Neolithic existence profitable to them. This extended broad-spectrum economy (Louwe Kooijmans 1993a, 1993b) proved to be highly successful and could easily be combined with a semi-nomadic existence. As Raemaekers stated (1999: 191-192) the Swifterbant people are the first native community in Northwestern Europe to experiment with the combination of benefits of both old and new subsistence strategies, resulting in an attractive and apparently ideal mixture. Whether this stock of ideas formed the basis for the eventual neolithisation of similar communities in Scandinavia and the British Isles, or whether these areas had their own 'Neolithic revolution', may be debated. It is, however, clear that it must have been a gradual process, with ups and downs, possibly even with the

3 For more information on these topics see for example De Grooth 2005, De Grooth & Van de Velde 2005, Lanting & Van der Plicht 2002, Louwe Kooijmans 2005, Price 2000, Raemaekers 2005, Schreurs 2005, Whittle 1985.

4 For more information on the Linear Bandceramic culture see for example Modderman 1970, 1985, Van de Velde 1979, 1992, Bakels 1978, 1982, 1987, Bohmers & Bruijn 1959, De Grooth 1987, 2003, Newell 1970, Theunissen 1990.

5 For more information on the Rössen culture see Fiedler 1979, Gehlen & Mischka in prep, Lüning 1982, Richter 1997, Spatz 1996, Stöckli 2002, Van der Waals 1972.

6 This chronological division is taken from Lanting & Van der Plicht (2002: 19, 47-48).

acquisition, loss, and re-acquisition of knowledge, ideas and perceptions.

2.2.3 *Second half Middle Neolithic A or the Late Swifterbant versus Michelsberg and the Hazendonk group (c. 3900 – 3400 cal BC)*

This period began with the initial development of a new cultural group, the Michelsberg culture (MK). It is the Bischeim Group that forms the transitional phase between the Rössen and this new Neolithic culture (De Grooth 2005: 295, Richter 1997). As hesitant steps were taken outside the loess area by the Bischeim Group, the Michelsberg people exploited these areas to the fullest. As said above, the Swifterbant culture was gradually replaced from the south to the north. The initial steps were taken in the Scheldt basin where the Michelsberg culture replaced the Swifterbant culture at around 4000 cal BC (Crombé et al. 2002).

The Hazendonk Group, formerly known as the Hazendonk 3 Group (Raemaekers & Rooke 2006), is the second new culture introduced in this period. It replaced the Swifterbant culture in the Rhine/Meuse area at around 3800 cal BC (Raemaekers 2003/2004: 29). In this way, the Swifterbant culture only survived in the northern part of the original cultural area.

Finally, at the start of the Middle Neolithic B (c. 3400 – 2800 cal BC) the Swifterbant culture was also replaced in the IJssel/Vecht/Eem system by the Funnel Beaker culture at 3400 – 3300 cal BC. From that time onwards, the separate cultural evolutions came to a climax. In the north of the Netherlands the Funnel Beaker culture (TRB West Group) developed, whereas in the south Stein and the Vlaardingen culture appeared.

2.3 The Swifterbant culture, both Mesolithic and Neolithic

The Neolithic Revolution, i.e. the domestication of plants and animals, is often seen as one of the greatest achievements of humankind. The Neolithic was an intriguing time in history when changes in all aspects of everyday life gradually came about. Different economic, social, and ideological views and perceptions spread over vast areas of the Near East, Europe and Asia and ultimately across the world, but these changes arose in different mixtures and arrangements, and at different paces.

The debate on whether a culture is Mesolithic or Neolithic is related to one's point of view. Over the last 145 years the definition of the Neolithic has depended on the presence of ground or polished stone tools (Lubbock 1865), agriculture (Thomas 1993), sedentary existence, or pottery (Childe 1925). As it turned out, these elements are not inextricably linked. One of the solutions is the development of new terminologies such as Ceramic Mesolithic, Pre-Pottery Neolithic or Forest Neolithic (Zvelebil 1986). Another is the determination of a prime and single characteristic. According to many researchers, but not all, the most important feature of the Neolithic is the existence of agriculture. The presence of cultivated crops or stock is the defining criterion of the Neolithic followed in this study.

Chronologically speaking the Swifterbant culture is set in the Early Neolithic B and Middle Neolithic A of Dutch prehistory (Lanting & Van der Plicht 2002, Raemaekers 2005). This is no surprise as the Early Neolithic A is reserved for the Linear Bandceramic culture. Yet, the Swifterbant culture can be defined as a transitional phase between the Mesolithic and the Neolithic on the Pleistocene coversands.

Simply put, as the early Swifterbant people are in fact Late Mesolithic hunter-gatherers that have adopted pottery from their neighbours (c. 5000 cal BC), they are rightfully described as Final Mesolithic people (i.e. Crombé et al. 2002, Sergant et al. 2006). Once they adopted animal husbandry (4600 cal BC) and crop-growing (4200 – 4100 cal BC) they can be defined as Neolithic (i.e. Raemaekers 1999, 2005).

2.4 The currently known Swifterbant sites

Over the years, the Swifterbant sites have become more numerous. Today roughly 22 sites are known (figure 2.1). Some of them are clearly defined as Swifterbant; the designation of others is more problematic. The multiple occupation phases of several sites often place them into more than one time frame.

The currently known Early Swifterbant sites[7] (5000-4600 BC) are Hardinxveld-Giessendam De Bruin, Hardinxveld-Giessendam Polderweg, Almere-Hoge Vaart, Doel, Bazel-Sluis, Ede-Rietkamp[8], and Bronneger. Parts of the assemblages at Hüde I and Schokland-P14 are assigned to this early phase based on radiocarbon dates, and Meppel-De Gaste may belong to this phase as well.

For the Middle Swifterbant phase (4600 – 3900/3800 BC) the IJssel/Vecht/Eem river system includes the Swifterbant sites S2, S3, S4, and S51, together with Nagele-J112, and parts of Hüde 1 and Schokland-P14. The Rhine/Meuse

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7 In this section 2.4 the different sites are only mentioned by name; the phases to which the different Swifterbant occupations belong to are mentioned in section 6.2.

8 Lanting & Van der Plicht (2002: 19) attach little value to the radiocarbon date from the potsherds of the single vessel found at Ede-Rietkamp. On morphological basis, they see more similarities of the pottery to the Hazendonk Group than to the Swifterbant culture.

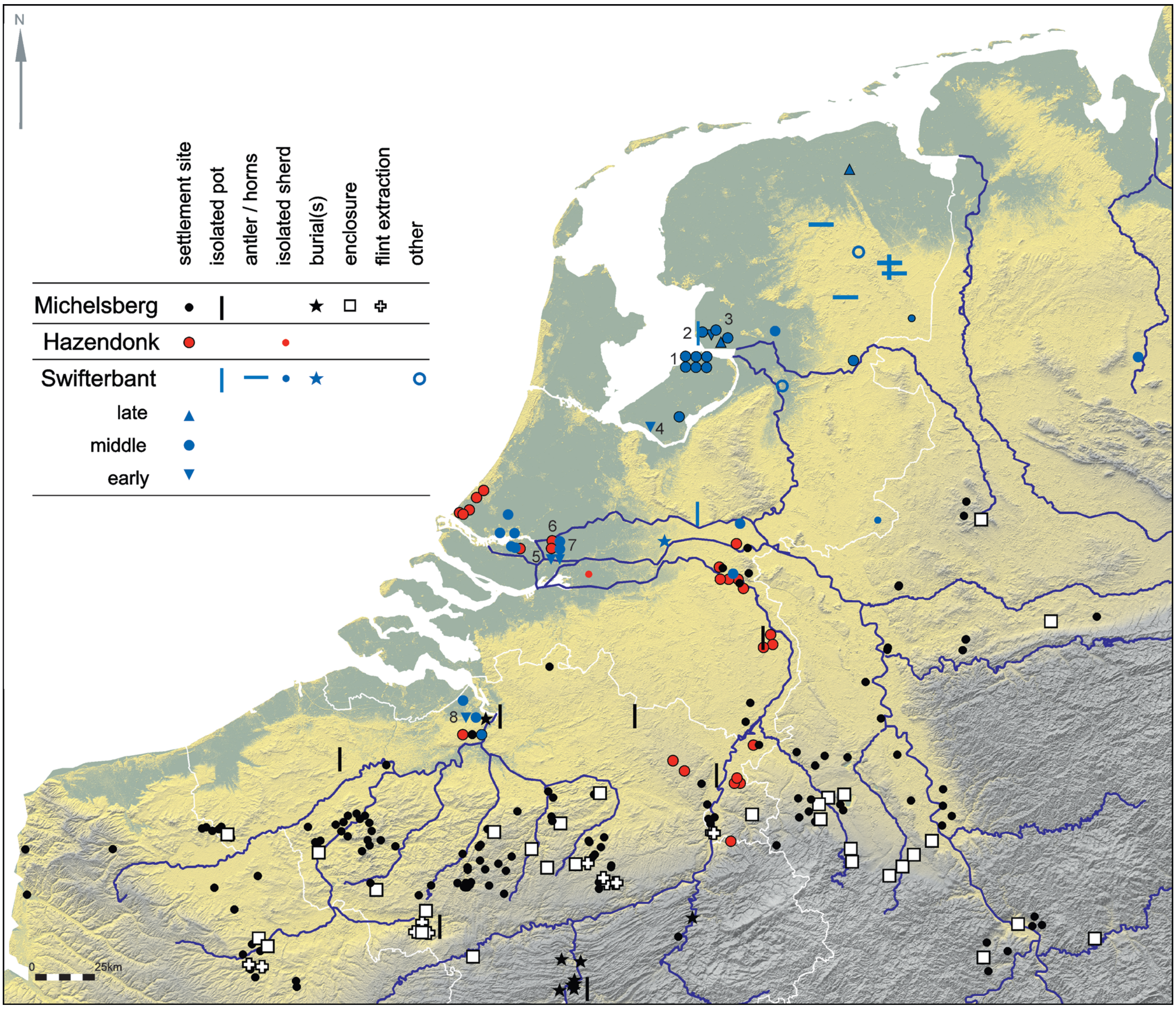

Figure 2.1 The Lower Rhine Basin showing sites of the Michelsberg culture, the Swifterbant culture and the Hazendonk group around 4300 – 3400 cal BC. Adapted from Louwe Kooijmans & Jongste 2006: fig. 27.4, with new additions. Key: 1: Swifterbant, 2: Urk, 3: Emmeloord, 4: Hoge Vaart, 5: De Bruin, 6: Brandwijk, 7: Polderweg, 8: Doel.

river system incorporates Brandwijk, Hazendonk 1 and 2, Bergschenhoek, and Zoelen-Buren. Doel is the only site in the Scheldt basin. The dating of the pottery from Schiedam and Winterswijk is less certain yet is assigned to this phase by Raemaekers (1999: 108).

The currently known Late Swifterbant sites (3900/3800 – 3400 BC) are Schokkerhaven-E170/171[9], Schokland-P14, Urk-E4, Emmeloord-J97, and Wetsingermaar.

Sites to the south of the IJssel belong to the Hazendonk Group. These are for example sites like Gassel (Verhart & Louwe Kooijmans 1989), Hazendonk itself (Louwe Kooijmans 1974, 1976), Linden-Kraaienberg, Rijswijk-A4, Schipluiden (Louwe Kooijmans & Jongste 2006), Wateringen 4 (Raemaekers et al. 1997), Wijchen-Het Vormer (Louwe Kooijmans 1980), and Ypenburg (Koot et al. 2008, Koot & van der Have 2002). Other sites mentioned in various articles (Louwe Kooijmans & Verhart 1990, Louwe Kooijmans 2005, Amkreutz & Verhart 2006) are Grave (Verhart 1989), Zoelen, Nijmegen-'t Klumke, Meeuwen (Creemers & Vermeersch 1989), and several find locations with Hazendonk pottery in Limburg.

2.5 The Swifterbant site, a research history

2.5.1 Introduction

The information given in the upcoming sections, especially in section 2.7, is largely based on the old excavations and publications, more specifically the excavations conducted between 1964 and 1979 and the articles published between 1972 and 1986. Some of the more recent information, from excavations or otherwise, dating between

9 This site is currently still largely unpublished.

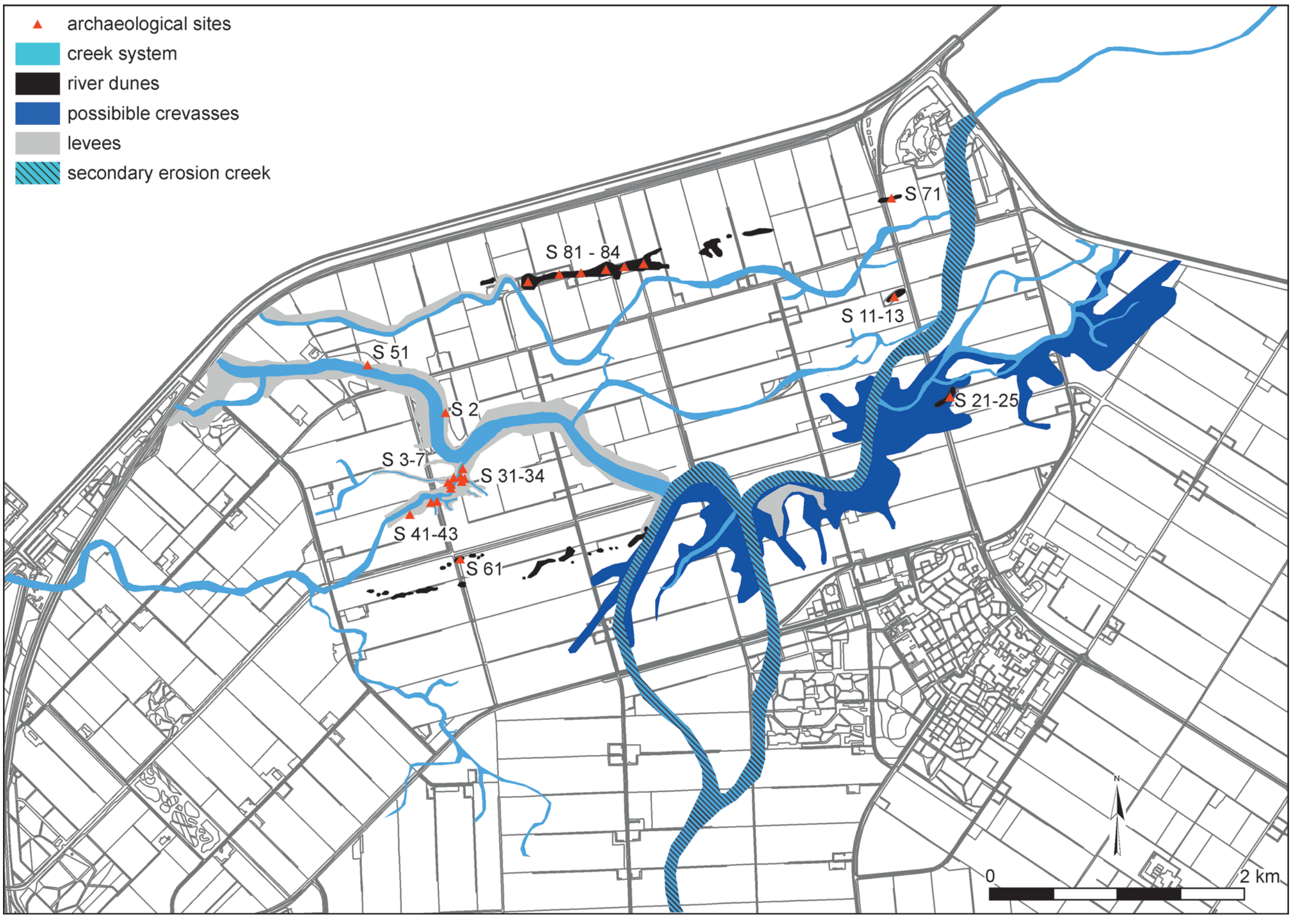

Figure 2.2 *Sites of the Swifterbant cluster (overall view). Adapted from Dresscher & Raemaekers 2001, fig. 3.*

2000 and 2012 will be addressed separately. Furthermore, one will also observe that the information on flint and stone artefacts retrieved from the old and new publications, and given below, is rather limited or even nonexistent. A review of all lithic artefacts is given in chapters 4 and 5, whereas a full description of most of the lithic artefacts is given in the catalogue. For a detailed description of the pottery see de Roever (2004, 2009), Raemaekers (1999, 2010) and Raemaekers & de Roever (2010).

2.5.2 The discovery of the site and the first few years of research and debate

The events that led to the discovery of the Swifterbant site take us back to the mid-twentieth century. At that time, the government wanted to reclaim parts of the IJsselmeer area so the land would be available for agricultural purposes. When the construction of the dikes was finished in 1956, the Polder Eastern Flevoland gradually started to dry out in the subsequent years. Ditches with a depth of 1.5 m were dug to divide the land into large parcels of 300x800 m. The slopes of these ditches made cross sections of hundreds of metres through the whole polder area, leaving buried layers visible to the naked eye. For the Research Division of the Polder Development Authority (RIJP: *Rijksdienst voor de IJsselmeerpolders*) this was the perfect opportunity to assess the agricultural potential of the area by conducting a systematic pedological and geological investigation. In the course of this survey, a submerged system of creeks and levees was discovered in the northern part of the polder, near the town of Swifterbant (figure 2.2). The first evidence of human occupation in the area was the discovery of Bell Beaker material on parcel H4 in 1959. The first evidence of what later would be known as the Swifterbant culture was most likely the recovery of potsherds by Mr Aukema (Technical Division of the Polder Development Authority) on the natural levee between parcel G41 and G42 during the digging of the ditches. Although the exact date is unknown, this was presumably between 1959 and 1961. In the summer of 1961, two more observations were made: first, in July or August, the identification of a charcoal filling of a hearth in a lacquer peel of the river dune on parcel H46; second, shortly before September 25th in 1961, the discovery of more pottery, flint, and charcoal during the cleaning of the ditch talud in between parcel G41 and G42. In the following years, further research and detailed investigation of the ditch slopes would provide more information on these locations. Besides these detailed ditch surveys by the geologists of the Research Division a systematic coring campaign was started in the region as well (Van der Waals & Waterbolk 1976).

The potsherds recovered by Mr Aukema at the Swifterbant site were, however, not the first evidence of the Swifterbant culture in the Netherlands; that would be the Weerdinge potsherd (Lanting & Van der Plicht 2002: 25) and the Schiedam potsherd. The former is published by Buiskool (1947) and Van der Sanden (1997), the latter by Modderman (1955) who defined the base of the pot merely as being Neolithic. Against the background of the beliefs of that day of the affinities between the Neolithic material from the Dutch coastal area and the Ertebølle culture, affinities between the pottery of the Swifterbant site with the pottery of the Ertebølle were quickly noted (Van der Waals 1972, Louwe Kooijmans 1976, de Roever 1979)[10]. The presumed link between the newly discovered material and the Ertebølle culture is not that surprising as the pottery is fairly similar, especially in general shape and forms of decoration. Yet, technically it is substantially different. It is this characteristic that Raemaekers (2010, 1999, 1997) finds very significant as a means of distinction. The individual character of Swifterbant and Ertebølle types of pottery, and the entire cultures for that matter, is accepted here.

2.5.3 General excavation history

After the discovery of the submerged system of creeks and levees the first trial excavations were undertaken by G.D. van der Heide of the archaeological department of the RIJP at polder sections G and H. Campaigns were carried out in 1962, 1964, 1966 and 1967 on the river dune of parcel H46 and the natural levee of parcel G42. In his articles Van der Heide (1966a, 1966b) also mentioned several stray finds in these two polder sections but did not give the precise location of these artefacts. Therefore it is unclear which sites were discovered by him. Because of this, but also because of the fact that these articles give no real details, are ill-documented and contradict with other articles, the first few years of the excavations at Swifterbant are not well-known.

An agreement between the Head of the RIJP, the Directors of the State Service for Archaeological Investigations, and of the Biological-Archaeological Institute of the University of Groningen (BAI) resulted in a plan for systematic excavations of the Swifterbant sites in 1971. The co-operation with the University of Michigan (Ann Arbor) and the University of Wisconsin (Madison) resulted in the first research in The Netherlands inspired by the principals of the *New Archaeology* as defined by Binford. In the following years, J.D. Van der Waals (BAI) conducted a second series of excavations in co-operation with various other organisations, like the Geological Institute of the University of Groningen, the geological department of the Research Division of the Polder Development Authority, the department of Physical Geography and the Institute of Anthropobiology of the University of Utrecht, the Section Parasitology from the department of Tropical Hygiene of the Royal Tropical Institute of Amsterdam, and the Institute of Pre- and Proto-history of the University of Amsterdam (Van der Waals & Waterbolk 1976: 8). All excavations conducted between 1971 and 1979 by the BAI and the two American Universities were excavated using a similar technique of 1x1 m squares[11] in which the finds were recorded three-dimensionally. Due to the compact and sticky character of the soil many small objects may have eluded the excavators. Consequently, the decision was made to sieve the soil, dug away around the larger artefacts and collected in layers of 10 cm within each square, through a 2 mm sieve (ibid: 11). It is, however, not quite clear whether or not this happened systematically. There is evidence of sites on which this was not possible and researchers were limited to collecting and sieving 3 litre probes of every square, particularly site S51 (Deckers 1979: 165). Examination of the old Swifterbant articles, the field notes and interviews with former researchers leads to the conclusion that neither the RIJP nor the BAI used drainage during their excavations. This is a rather significant detail never published in any of the 'old' Swifterbant publications[12]. Without drainage the depth of the excavation trench is dependent on the level of groundwater. Therefore, the researchers had to wait for an exceptionally dry summer to excavate trench S5 on parcel G43.

During the systematic excavations of 1971 to 1979, two large coring campaigns were also carried out to intensify the knowledge on the palaeogeography of the area, especially with regard to the genesis of the creek system and to determine the nature of the uncovered cultural layers. The first study was carried out in 1972 and 1973 by L. Hacquebord (1975, 1976) and focussed on the parcels G36 to G45. The aim was to map the creek and levee system, and maybe even find new traces of occupation, so the corings were plotted with an interval of 100 m. Only on specific spots were the corings intensified to 2 or 3 m apart (Hacquebord 1975). As hoped, the research resulted in the discovery of some unknown sites. Because of the large coring grid, the seven settlements in the vicinity of parcel G43 could not be documented in detail. Along with the fact that Hacquebord did not describe the occupation areas at all, he just depicted them on a map without any labels[13]; this resulted in a rather inaccurate picture. The second study in 1977 was conducted by H. Fokkens who aimed for detail. In this study (Fokkens 1977) a smaller

10 For a discussion on this topic see Raemaekers 1997.

11 Except for a trench of 5x30 m on site S3 (see below).

12 Articles published between 1972 and 1986.

13 The sites did not receive their final designation until 1978.

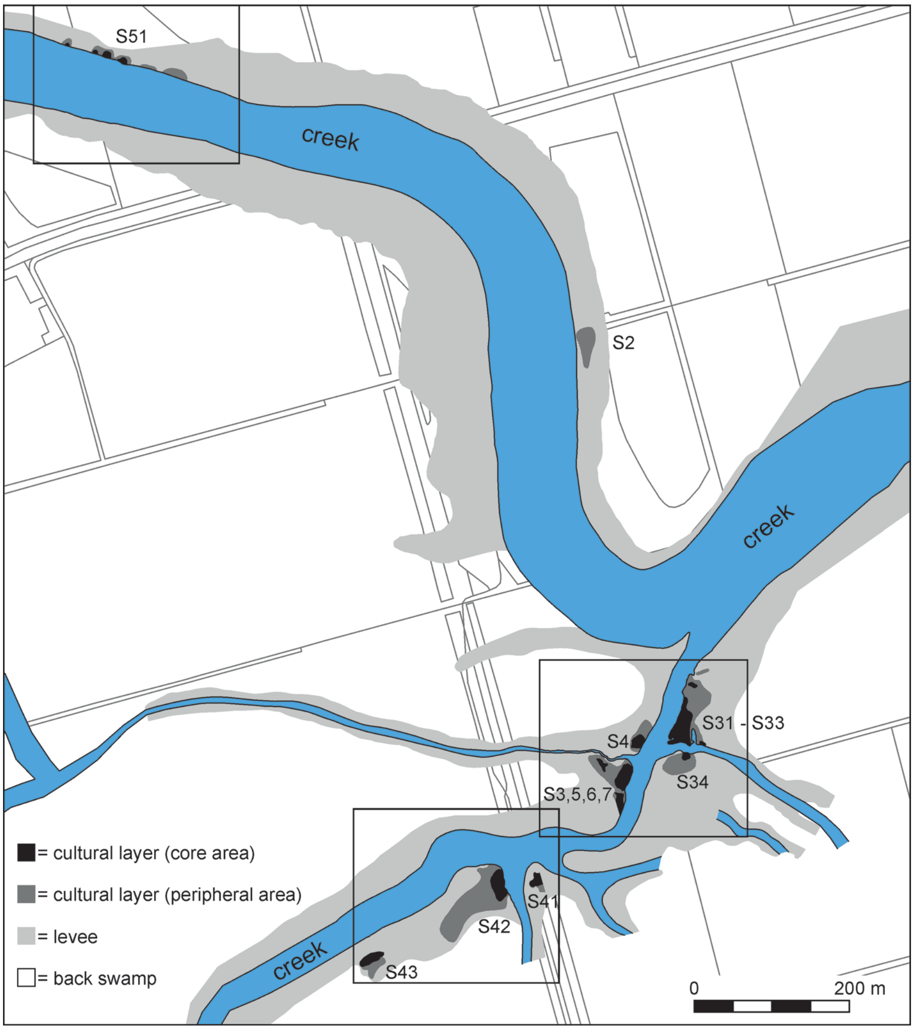

Figure 2.3 Sites of the Swifterbant cluster (detailed map) and location of figures 2.8, 2.9, and 2.10. Adapted from Deckers 1979, fig. 2.

coring grid was used to determine the nature and exact size of the cultural layers. This thorough research resulted in the discovery of four more sites. Fokkens characterised most occupation layers as areas with a dark to black coloured core region and a lighter, greyish periphery (also see section 2.6); in several instances this periphery contained more than one core. In total, eleven sites were found and investigated by Hacquebord (1975) and Fokkens (1978) (figure 2.3). These include three individual core regions with their own periphery (S41, S42 and S43) on parcel G39, two areas with three core regions (S3 and S31-S33) and two areas with only one core (S4 and a site which previously never received an 'S' designation but was recently designated S34) on parcel G43, a site with one core in a peripheral area (S2) on parcel G42, and four areas of lighter grey soil (S51) on parcels G15 and G16. Two of these peripheries show no core region; one periphery encloses three closely spaced cores and the last periphery contains one core area.

During the course of this Ph.D. research, an erroneous mapping of one site was discovered. Hacquebord (1975, 1976) and Fokkens (1978) both located site S31 at the northern side of a small creek, opposite site S4. All Swifterbant articles published subsequently used Hacquebord's map of the area. In 1978/1979 Constandse-Westermann and Meiklejohn (Meiklejohn & Constandse-Westermann 1978: fig. 1, Constandse-Westermann & Meiklejohn 1979: fig. 1) started using a different map picturing a larger section of the polder area. This one was based on a drawing in Ente's article from 1976 (Ente 1976: fig. 5). Remarkably, the location of site S31 had shifted from the north side to the south side of the creek and was now situated opposite site S3. This discrepancy was not discovered until February 2004 and therefore both maps have been in circulation ever since their first publication. Because Hacquebord's and Fokkens' maps are based on data from coring campaigns, I am inclined to believe that the location of site S31 on these maps is correct. Therefore, sites S31-S33 is the large peripheral area with three core areas north of the tributary, and site S34 is the small site with one core region south of the tributary.

A second error on the map of Meiklejohn and Constandse-Westermann (1978: fig. 1, Constandse-Westermann & Meiklejohn 1979: fig. 1) may be the location of site

S81 on parcel H3. The possibility remains this site is actually located on parcel H4 (see section 2.7.17).

More recently, several new excavation and coring campaigns have been undertaken. The goal of these investigations is diverse ranging from prospection, through evaluation, to full scale excavation.

In 1993, flint artefacts and potsherds were uncovered in the ditch slope on site S82 on parcel H2 (Jordanov 2005). Another ditch slope inspection later that year resulted in more finds.

In 2000 a coring campaign was carried out by *RAAP Archaeological Consultancy* on site S71 (Raemaekers 2000). At the time, there were plans to create a water basin in the area. The research was carried out to gain more insight in the river dune topography and determine where the basin could be allocated without threatening the dune. The research revealed traces of charcoal, and two pieces of flint on the higher parts of the dune.

In 2002 two test trenches (2x2 m) were dug on site S83 by the province of Flevoland (Dutch State Service for Archaeological Heritage Management) in cooperation with local amateurs. As part of the research, some 140 corings were carried out on sites S82-S84 (see section 2.7.17).

The New Swifterbant Project by the Groningen Institute of Archaeology (GIA) started in 2003 by making an inventory of the information still available and the publication of the new research aims and questions (see Raemaekers et al. 2005). Excavations followed on site S2 in 2004 and on site S4 in 2005, 2006, and 2007 (see sections 2.7.2 and 2.7.4). In 2008 a coring campaign was conducted at parcel H46 (trenches S21-S24) revealing a promising area between the dune and the river. It is this area, designated as trench S25, which was under investigation in the 2009 and 2010 research campaigns.

2.6 The geological development and the natural environment

The landscape in and around Swifterbant essentially exists of two components: the Late Glacial / Early Holocene river dunes and the Holocene levees. The substrate on which the Holocene landscape of the Flevoland polders could develop consists of three elements. These are the glacial deposits from the Saalian, the periglacial deposits of the Weichselian, and the aeolian river dune sands from the Weichselian / Early Holocene (Ente & Wiggers 1963, Peeters 2007). During the Late Pleistocene, when vegetation was sparse, eolian erosion and redeposition created the coversand topography that characterises most of the northern Netherlands. In this period, windblown sands of dry river banks and sand banks in between streams created river dunes at the borders of large open valleys. After the Allerød the sand dunes had largely formed and sanddrift would decline as vegetation became denser. This landscape forms the start and setting of the Mesolithic occupation within the area. Several local drainage systems had established in the landscape, including the precursors of the Overijsselse Vecht and the IJssel (figure 2.4). At that time, the IJssel must have been nothing more than a small, low energetic brook or river system and was not connected to the Rhine as the main drainage system.[14] Seemingly, the rivers formed two separate systems of which the Vecht is located more northerly than the IJssel.[15] Both river systems are characterised by a series of east-west running aeolian river dunes (Ente et al. 1986, Peeters 2007, Cohen et al. 2009).

The second component of the landscape at Swifterbant are the Holocene levees. These formed in the Mid-Holocene during which a relatively stable, wooded landscape developed along the tributaries of the fresh water river system of the Palaeo-IJssel. Along with the change of climate during the Holocene came a relative sea level rise. At the end of the Atlantic, beach barriers or barrier islands were forming along the coast which had roughly the same position as today. In the area between the coastal barrier and the peat hinterland, known as the intracoastal area, a lagoon developed. Through the inlets between the barrier islands sand and clay were carried into the lagoon and deposited as tidal flats and other lagoon bottom deposits. Fresh water was brought in by rivers in the east which may have led to more lacustrine conditions. The continued rise in sea level caused the intracoastal environment to extend even more to the east. For approximately 1000 years, the sedimentation of the river system kept pace with relative sea level rise, raising itself with some 5 m of sediments. This created a stable and protected environment at Swifterbant. Even though the levees were built by clay from the coast, deposited through an open connection with the sea, the fresh water river system was only under a limited influence of low and high tide (Schepers et al. 2013). Only occasionally the area would be flooded. This is different from other river systems, for example that of the Eem in Zuid-Flevoland, where other tidal dynamics applied (pers. comm. J.H.M. Peeters 2013). These different tidal influences may have been important for the accessibility of the hinterland and/or for transportation.

The final stage at Swifterbant would be the gradual flooding and drowning of the area. First the levees drowned as the result of sea level and groundwater rise, covering them by peat deposits. Before the area would turn into a fresh

14 The precursor of the IJssel is referred to as the "Oer-Hunnepe" (Cohen et al. 2009: 88), yet in this publication the term "palaeo-IJssel" (see Besse-Lototskaya et al. 2010) will be used to avoid confusion.

15 As only the western part of the river systems are currently clearly mapped, it is unknown whether both systems were ever connected (see Cohen et al. 2009: 88).

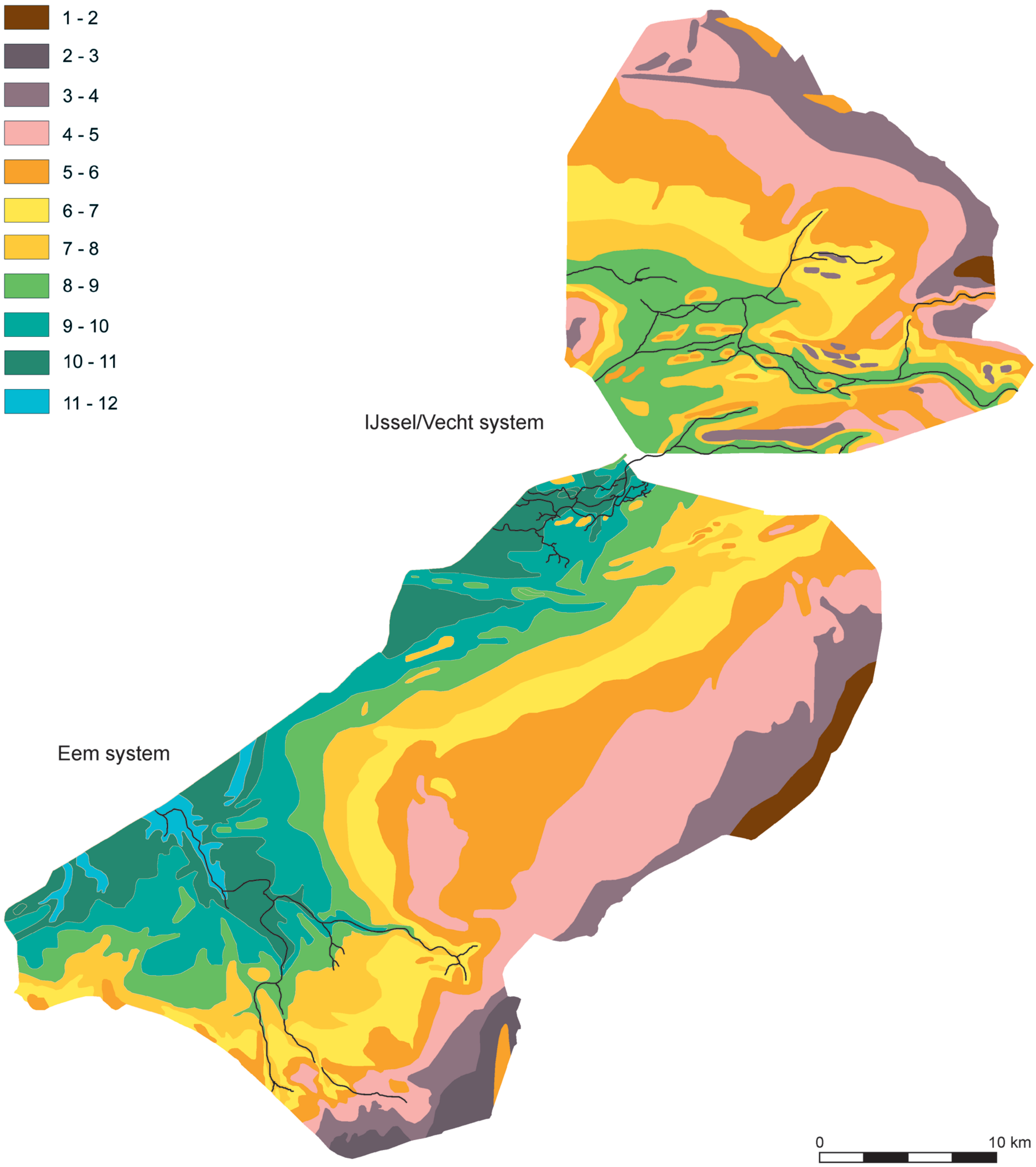

Figure 2.4 The river systems Vecht, IJssel and Eem. Adapted from Peeters 2007, fig. 3.3, and completed with Dresscher & Raemaekers 2011, fig. 3.

water lake (the IJsselmeer) the crests of many river dunes and the top of the peat deposits were eroded, resulting in a thin layer of coarse-grained yellow eroded sand. Finally, the whole area was covered by sediments of the Almere, Zuiderzee, and IJsselmeer phases of water levels (Ente 1976, Hacquebord 1976, Price 1981, Deckers et al. 1980).

Initially, it was believed that the levees drowned shortly after 4000 cal BC while the river dunes, some of which reach a metre higher than the highest levee, were covered around 3700 cal BC. However, recent research revealed that the levees were still exploited after 3900 cal BC, possibly even until 3700 cal BC (Raemaekers 2011a and b). It would appear that even though the main occupation phase at Swifterbant is dated between c. 4300 – 4000 cal BC, other exploitation phases occurred both before and after this occupation (Huisman et al. 2009, also see section 2.7.2). Seeing that the highest levee sites are as high as some of the river dunes this may not come as a surprise.

At the beginning of the Neolithic habitation in this fresh water river system, the area was characterised by a well-developed system of creeks with levees and backswamps combined with river dunes that for long formed out-cropping heights which were clearly visible in the Holocene

Table 2.1 Height of levees and river dunes

	Sites	Average thickness	Top level	Lowest level	Total surface	Core	Periphery	Excavated	Excavated
			in - NAP	*in - NAP*	*in m²*	*in m²*	*in m²*	*in m²*	*in %*
Parcel G39									
L	S41	20 cm	5.00	5.50	375	275			
I	S42	10-25 cm	4.90	5.30		800	3500		
K	S43	25-30 cm	5.50	6.00	600	350			
Parcel G41			5.40	6.00					
Parcel G42	S2	20 cm	5.30 *	5.50 *	800 **			c. 460	58%
Parcel G43									
Peripheral area		20 cm	5.10	5.60	c. 2700				
D	S31	20-50 cm	5.10	5.60		1200			
E	S32	30 cm	5.10	5.40		125			
Q	S33	10-20 cm	5.10	5.30		50			
C	S34	10-20 cm	4.95	5.50	1100	100			
Peripheral area		30 cm	5.30	6.15	c. 1200				
	S3	50-60 cm	5.40	6.00		630/760 **		c. 430	57% - 68%
H	S6	30 cm	5.70	6.15		125			
F	S7	10-20 cm	5.30	5.50		200			
	S4	20-40 cm	5.90	6.30		425/600 **		140	23% - 33%
Parcels G15/G16	S51								
N		15 cm	5.30	5.60	100	25		75	
M		20 cm	5.30	5.50	225	150		45	53%
O		10-15 cm	5.30	5.40			75		
P		10-15 cm	5.40	5.60			200		
River dunes	S11		4.90	5.75 ***					
	S11-S13				9500			564	
	S21		3.90						
	S22		3.70						
	S21-S24				5275			850/877	16% - 17%
	S61		4.70	6.10 ***	3400			60-75	2%
	S71				10500				
	S80-S84				90000			4	

* The values by de Roever (2004: 22) are set between 4.95 en 5.20.
** Estimated area.
*** Lowest excavated level.

landscape[16]. The creeks carried the fresh water from the hinterland but were also subject to sporadic storm influences from the sea (De Wolf & Cleveringa 2005). In this freshwater environment the river dunes provided permanent high, dry places while the lower lying levees flooded occasionally (Ente 1976: 32). The natural vegetation on the levees consisted of a deciduous forest of ash, elm, wild apple, alder, hazel, hawthorn and some oak. In the backswamps open marshland vegetation and willow carr were present. In those places where alder carr was cut down it was possible for a damp grassland vegetation to develop. On the river dunes there were mainly larger trees forming a mixed forest of oak, ash, lime, and some hazel with alder predominating at the foot of the dunes. In open places in the vicinity of the habitation sites anthropogenic vegetation occurred; these are plants such as plantain and

16 The highest tops of the river dunes reach as high as -4 m NAP (= Dutch Ordnance Level), while the highest level of the dune sand of site S61 is -4.7 m NAP, and that of trench S11 -4.9 m NAP (de Roever 2004: 14).

common knotgrass which can withstand being trodden on (Casparie et al. 1977, Van Zeist & Palfenier 1980).

The living conditions differed from levee to levee as some of them were more vulnerable to flooding than others due to their variable heights (table 2.1). The top of the levee of site S2 is situated between c. -4.95 m and -5.20 m NAP (= Dutch Ordnance Level). The cultural layer of site S2 is present at -5.30 m NAP and extends to -5.50 m NAP. The top of the levee of site S3 is at -5.40 m NAP whereas its lowest point is documented at -6.00 m NAP (Fokkens 1978)[17]. The height of the other core regions near site S3, namely site S6 and S7, vary widely. Site S7 is positioned on an elevation, while site S3 is located on a lower part of the levee. Site S6 is located at the lowest point. The very low position of site S4 is presumably the result of its general position in the creek system; the levee developed on top of a former creek. Site S51 is at the same level as site S2, roughly between -5.30 m and -5.50 m NAP. The highest levee sites are sites S31-S34 (between -4.95 m and -5.10 m NAP), of which the highest top is as high as one of the river dunes (Fokkens 1978).

The river dunes formed clearly visible landmarks in the area because of their hight. According to de Roever (2004: 14) the highest tips of the dunes reached -4.00 m NAP, with the top of the dune exposed in trench S11 being located at -4.90 m NAP, and the top of the dune at site S61 even at -4.70 m NAP. However, the two tops of the dune on parcel H46 roughly reach -3.70 m and -3.90 m NAP (Price 1981). The hearths in trenches S21-S24 are positioned between -4.50 m and -5.15 m NAP (de Roever 2004: 14), whereas the graves and human remains are located between -4.45 m and -4.95 m NAP for trench S21, and -4.65 m and -5.84 m NAP for trench S22 (Meiklejohn & Constandse-Westermann 1978).

Much of the above mentioned information on the dynamics of the river system derives from the work of Ente (1976) and Hacquebord (1976) whereas more detailed information on the levee sites themselves was published by Fokkens (1978). His coring campaign revealed that within a cultural layer of a levee site different kinds of black colourations were to be distinguished. By identifying them on a Munsel soil chart he distinguished core regions with mainly black colourations and peripheral regions with mainly grey colourations. Fokkens explained the grey peripheral areas as trampling zones around the black occupation areas. For sites S42, S43, and S34 he even suggests an interpretation as a possible agricultural area (ibid: 3). As sites S2, S3 and S4 also revealed traces of periodical use as agricultural fields (Huisman et al. 2009, Huisman & Raemaekers in prep.) this interpretation must be considered.

Additionally, Fokkens' research (1978) revealed the presence of different occupation phases. The peripheral area between sites S7 and S3 runs under the core region of S3 and is separated by a band of clay indicating the older age of site S7 (ibid: figure 23). At the south of site S3, the black soil of the lowest layers extends under site S6, again separated by clay. On top of that a new layer was visible coloured black at both sites and divided by a grey peripheral area.

2.7 A detailed research history of the individual sites at Swifterbant

2.7.1 Introduction

The currently identified Swifterbant sites are known to us because they were exposed when a parcel ditch[18] was dug through them or because their cultural layer or archaeological remains were drilled out during subsequent coring campaigns. These campaigns revealed the levee sites to have one or more core areas consisting of a dark grey to black soil in a peripheral area of a lighter grey colour. This dark grey to black soil is defined as a cultural layer and may vary in thickness. It is generally accepted that the longer the habitation, the thicker the layer. Unfortunately the accumulation rate cannot be defined as it is not only related to the duration of the occupation but probably also to the intensity and nature of that occupation. In addition, all layers are subject to settling of the ground of which the rate is also not established. The thickness of the layer is therefore not an exact record of the length of occupation although it might be considered an indication. The discoloration of the peripheral area is also presumably the result of human activity, yet of a lower intensity than in the core area. One might even imagine that trampling would have spread certain amounts of settlement waste and so contributed to the effect.

The question remains whether all the sites in the area are known to us. Even with the detailed digital elevation model (DEM, Dutch: *Actueel Hoogtebestand Nederland* - AHN) available now not all creeks or tributaries are visible. Deeper lying streams and levees, and possible settlement sites, may be hidden under a few metres of sediment. Future research and excavations might reveal more sites and give us a clearer view on the whole creek system and the systems beyond.

The Swifterbant cluster consists of a series of find locations in an area of approximately 18 km² in the Polder

17 However, de Roever (2004: 14) states that the top of the levee of site S3 is estimated between c. -5.15 m and -5.35 m NAP whereas its lowest level is estimated at -6.10 m NAP.

18 The polders are transected by two types of ditches. The main ditches are referred to as shoulder ditches (*tochtsloten* or *bermsloten*), the side ditches are referred to as parcel ditches (*kavelsloten*) (also see section 3.3).

Table 2.2 The designation of the sites of the Swifterbant cluster.

Site	Trench	Segment	Parcel	Geomorphology
S2 *			G42	Levee
S3	S5		G43	Levee
	S6			
S4			G43	Levee
S6 **			G43/G44	Levee
S7			G43	Levee
	S11		H34	River dune
	S12			
	S13			
	S21 ***	1, 2, 3a, 3b	H46	River dune
	S22 ***	4, 5, 6a, 6b, 6c		
	S23			
	S24			
	S25			
S31			G43	Levee
S32				
S33				
S34				
S41 **			G39	Levee
S42				
S43				
S51		1, 2	G15/G16	Levee
S61			G76	River dune
S71			H129	River dune
S80 ****			H4	River dune
S81			H3	River dune
S82			H2	River dune
S83			H1	River dune
S84			G20	River dune

* Formerly designated as location 10 (Van der Heide 1966)
** Formerly designated as location 11 or 12 (Van der Heide 1966)
*** Formerly designated as location 8 (Van der Heide 1966)
**** Formerly designated as location 7 (Van der Heide 1966)

Eastern Flevoland near the town of Swifterbant (see figure 2.2). Two geologically different site locations characterise the region. First there are two series of Late Glacial / Early Holocene river dunes that clearly rise above the prehistoric landscape. On these east-west oriented dunes, which were possible sites of habitation during the Mesolithic and Neolithic, five site locations have been discovered so far. These small or larger dunes are confined to one or two parcels as on H34 (trenches S11-S13), H46 (trenches S21-S25), G76 (site S61), and H129 (site S71). One larger dune complex is spread over four parcels being H4 (site S80), H3 (site S81), H2 (site S82), H1 (site S83), and G20 (site S84). On these sandy dunes, the definition of a site is far more problematic than on the levee sites (see below), therefore some are designated as trenches and some as sites. The second group of sites was found on several levees from a creek system. These are to be found on parcels G42 (site S2), G43 (sites S3, S4, S6, S7, and sites S31-S34), G39 (sites S41-S43), and G15/G16 (site S51).

Parcel G43 is the location where two tributaries join the side creek. The side creek itself joins the main creek. This

Table 2.3 The excavation campaigns at the different sites of the Swifterbant cluster.

Site	Excavation campaign	Supervision
S2 *	1964, 1967	Van der Heide /RIJP
	1971, 1975, 1976, 1977, 1978, 1979	van der Waals / BAI
	2004	Raemaekers / GIA
S3	1972, 1973, 1974, 1975, 1976, 1977	van der Waals / BAI
trench S5	1975	van der Waals / BAI
trench S6	1977	van der Waals / BAI
S4	1974	van der Waals / BAI
	2005, 2006, 2007	Raemaekers / GIA
S11-S13	1974	Price & Whallon / Wisconsin & Michigan
	1976, 1977, 1978 (only S11)	Whallon / Michigan
S21	1962, 1966	Van der Heide /RIJP
	1971, 1973	van der Waals / BAI
	1976	Price / Wisconsin
S22	1962, 1966	Van der Heide /RIJP
	1971, 1973	van der Waals / BAI
	1976	Price / Wisconsin
S23-S24	1976	Price / Wisconsin
S25	2009, 2010	Raemaekers / GIA
S51	1978	van der Waals / BAI
S61	1978	van der Waals / BAI

appears to have been a favourable location for habitation as a large number of sites are found here. To rule out any misunderstandings which might have been created over the years, by misprints or erroneous maps, I would like to recapitulate the situation on these levees. The area can be divided into four corners divided by 'crossroads' (see figure 2.7). Site S4, with one settlement core in a peripheral area, is located in the northern corner. In the eastern corner one large peripheral area encompasses three cores; these are designated sites S31-S33. In the southern corner a small peripheral area with one core region is labelled site S34. The last area in the west is again composed of three core regions in one larger peripheral area; sites S3 and S6 are already known, the one in the west can be designated site S7. Trench S5 is not a different occupation area; it merely is a specific trench of the site S3 excavations. It runs through the creek and is not a part of the settlement.

The designation of the different sites needs some clarification (tables 2.2 and 2.3). After the initial description by Van der Heide (1966a) as locations or *vindplaats* 7-8 and 10-12, the sites of the Swifterbant cluster were eventually designated as S2, S3, … with 'S' standing for Swifterbant, followed by a number signifying a different location. 'S' consequently does not stand for 'site', it merely indicates a research location. The different research locations may be a site or a trench. To elucidate, the term site is only given to spatially isolated find complexes such as site S2 and site S3, consisting of a core region in a peripheral zone on a levee (see section 2.6). S5 is designated as trench S5 as it is a research location on site S3, a specific trench to be precise. For the river dunes this is more complex. When the archaeological remains on a certain dune are restricted to one excavation per parcel, the research location is designated as site, for example site S61. When the dune is located on one parcel but consists of different research locations, these have received the designation of trench; for example trenches S11-S13 and trenches S21-S25. When the archaeological remains are spread over a river dune encompassing several parcels, the term site is used to designate the sections per parcel; for example sites S80-S84. The underlying thought is the possibility that the spread of artefacts on the river dunes may be one blanket of archaeological finds, no longer distinguishable from one another. For the sake of convenience these are thus separated by parcel.

2.7.2 Site S2 (parcel G42)

Research area

Pottery from this levee site presumably formed the first evidence in the area of what later would be known as the

Swifterbant culture. This may have been between 1959, the first evidence of human occupation to be recovered in the area in the form of Bell Beaker material on parcel H4, and the summer of 1961 when a charcoal filling of a hearth was identified in a lacquer peel of parcel H46 (see section 2.5.2). Site S2 was revealed and positively identified during the cleaning of a parcel ditch in 1961, when several potsherds, charcoal, and flint artefacts were retrieved from a black layer (Van der Waals & Waterbolk 1976: 4). Following the discovery, further research was conducted and preparations were made for a trial excavation at the site by the RIJP. In 1964 research started under the supervision of Van der Heide in a trench of 5x26 m (figure 2.5 and table 2.3) [19]. He continued research in the same trench in 1967 and enlarged the pit to 6x30 m. It should be mentioned that the coordinates of the individual finds were not recorded during this research (Deckers 1979: 148). Furthermore, there is a possibility that the excavated soil was not sieved as there are hardly any flint chips in the find material now available.

In 1971 Van der Waals took over the research as part of the BAI excavations. He enlarged the existing trench with a strip of 1x18 m[20] and completed research in that trench the same year. Over the years five more excavation campaigns would follow: in 1975 a trench of 5x18 m[21], in 1976 graves VII and VIII, in 1977 a small area of 5x6 m, in 1978 one large area comprising trenches of 5x6 m, 16x5 m, 1.5x6 m and 1.5x11 m. The final excavation by the BAI on site S2, and in Swifterbant as part of the 'old' excavations, was carried out in 1979 when the team excavated eight strips of 1 m wide in a 9x16 m area to the north of the existing trenches, outside the formal site as defined by the presence of a dark occupation layer.

The research of 2004 was the first excavation of the New Swifterbant Project of the GIA. The trial excavation was a fruitful campaign to get acquainted with the new research methods and excavation techniques (Prummel et al. 2009). Two trenches were excavated and a large number of cores taken (Raemaekers et al. 2005). A total of c. 17m² in an area of 3x9 m was excavated at the eastern side of the site. The soil was collected in squares of 50x50x5 cm and integrally sieved over 2 mm meshes. The second trench of 10x1 m, located more to the north, was excavated by shovelling. The 79 corings, positioned in a grid of 5 m mutual distance, reach as far as 45 m north of the boundary of the site.

Geology

The dark-grey occupation layer appeared to be intact and was sealed off by a sterile clay layer shortly after the occupation. A later erosion layer on top of the clay contained late Bell Beaker potsherds and a stone axe with oval cross section and thin butt[22] made of amphibolite was recovered at c. -5 m NAP. The dark occupation layer covers an area of 24x50 m, is c. 0.25 m thick and fades out to the west and east of the trench as it runs towards the main river gully and the back swamps. In the east the layer splits into two distinct layers, separated by a sterile clay deposit, providing proof of an interval between different occupation phases. Archaeological finds were primarily recovered from the darker part of the occupation layer (Van der Heide 1966a, Van der Waals & Waterbolk 1976: 7, Van der Waals 1977: 5).

After the discovery of the hoe-field on site S4 (see section 2.7.4) the micromorphological research was extended to site S2 and S3 (Huisman et al. 2009). Thin sections of the cultural layer of site S2 revealed the quick and repeated deposition of relatively clean clay layers. The absence of coarser sediment components suggests these occasional floodings were low-energy events. Even when the frequency of this flooding is unclear, it was observed that "each flooding was followed by a (dry) phase during which the deposited material was disturbed, and to some extent mixed with deeper soil layers" (Huisman et al. 2009: 189). The analysis revealed that these disturbed layers occur in the main archaeological level, i.e. the cultural layer, but also above and below this level. Huisman suggested that the type of activity causing these disturbances may be trampling or even animals rooting for soil fauna or discarded food residue. An interpretation gaining increased influence is the use as hoe-field (Huisman & Raemaekers in prep.). Therefore, it is possible that sites S2, S3, S4, and by extension all other levee sites, were used as a hoe-field or other, at some point in time.

Archaeological features and finds

Apart from nine graves, not many features were discovered at this site, not even hearths. Noteworthy is a row of eight stakes with diameters of 3 to 5 cm which were planted at mutual distances of 40 to 50 cm (Van der Waals 1977: 7). Possibly more than eight stakes were originally present at the site as the row ends at the edge of the excavation trench (Prummel et al. 2009: 19-20). A few years after the publication of Van der Waals, Deckers (1979:

19 As mentioned above, the first few years of the Swifterbant excavations are not well known and therefore these trench dimensions are given with due reserve.

20 On this subject Van der Waals (1977: 5) stated: 'In addition, a narrow strip (width 1.20 m) of the intact occupation layer could be excavated along the southern side of the trench.'

21 The trench dimensions (3.30x26 m) given by Van der Waals (1977: 5) contradict the excavation drawings and are therefore not followed.

22 The axe is defined as *Felsoval beile type 1b* (Brandt 1967) and made out of dark grey to black speckled amphibolite (contra Van der Heide 1966: 211, Hogestijn 1986: 277). Triangular in shape and with a plano-concave cross section, the artefact measures 118x59x29 mm and weighs 321.1 g. The flat side is smoothed with a little gloss at the butt end whereas the concave side is smoothed to polished. The cutting edge shows a bright gloss as the result of polishing. There is hardly any damage; only one or two small chips have been broken off at the cutting edge.

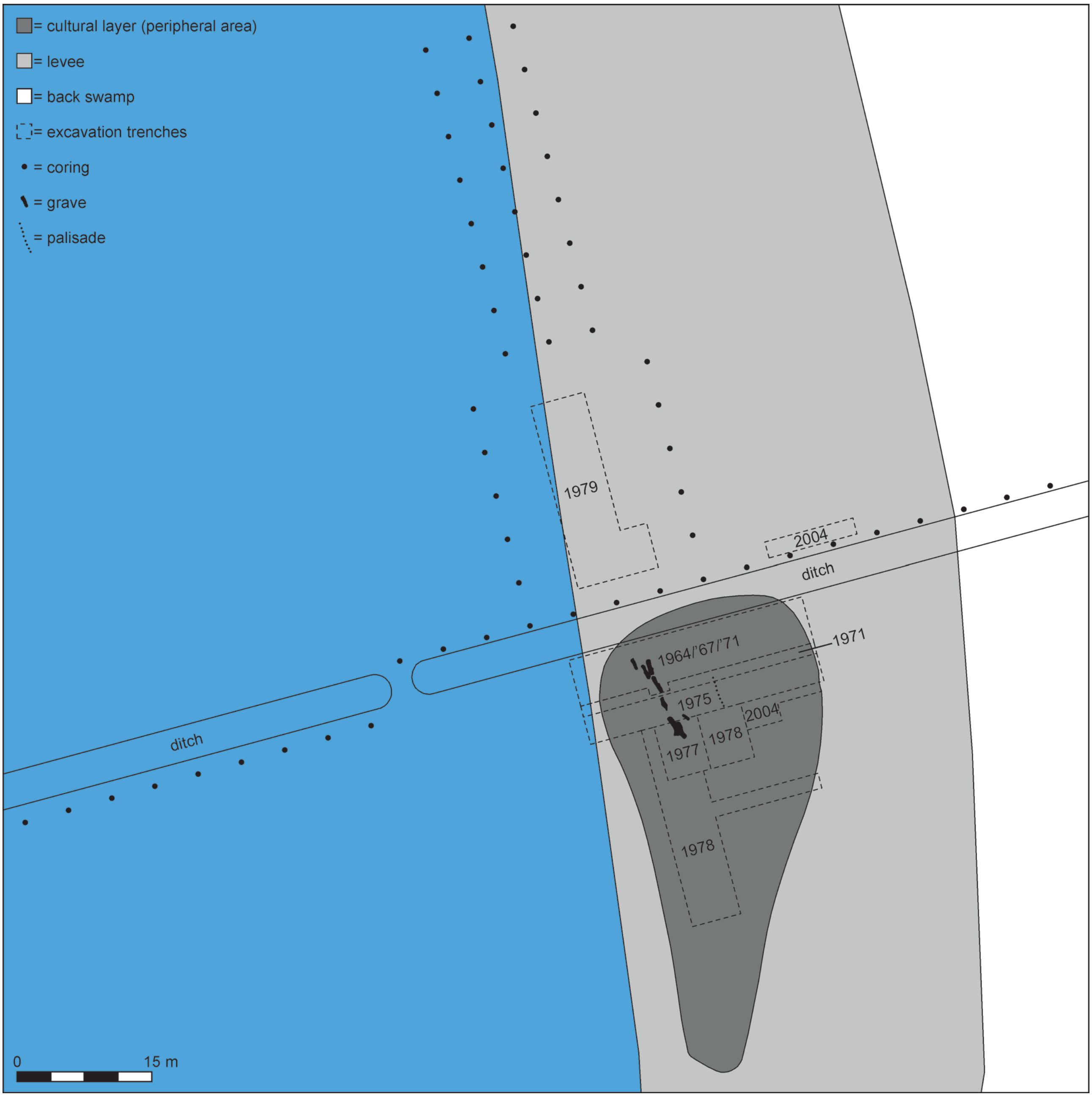

Figure 2.5 The different excavation campaigns at site S2. Adapted from Raemaekers et al. 2005, fig. 3.

147) mentioned a few poles and post holes as the only features, presumably referring to this row of stakes. The 2004 campaign revealed at least two more wooden posts, one in each new trench. The coring campaign might also have revealed a third post (Raemaekers et al. 2005: 125, Prummel et al. 2009: 35).

On the archaeological remains of the old excavations, Deckers (1979: 148) notes that site S2 yielded 1503 flint artefacts, of which 131 were found in the RIJP excavations. He also asserted that the flint artefacts were evenly distributed vertically through the occupation layer and that there was neither horizontal clustering nor any spatial relation to the graves on the site (ibid: 153-154). A flake found in association with grave I and a flake and blade with use-traces found in association with grave VI were also mentioned but the significance of these finds is uncertain (see below). De Roever (1979:16) mentions the presence of 2450 potsherds of which there were 177 rims and 8 bases.[23]

The archaeological remains from the 2004 campaign consisted of pottery, lithic artefacts, bone material,

23 Deckers (1979: table 2) mentioned 5708 potsherds from the 1978 excavations.

charcoal, wood, and charred cereal grains. As the number of potsherds and especially lithic artefacts was very low, and no features were found, this area is interpreted as the periphery of the site. The spread of archaeological remains in the second trench to the north was even less dense, also pointing to a peripheral area (Raemaekers et al. 2005, Prummel et al. 2009). The pottery, 247 potsherds in total, is tempered with red granite, and white quartz, sometimes with the addition of organic material. The pots are coil-built and rarely decorated, very similar to the material already found at the site (Prummel et al. 2009: 22-23). The charred cereal grains are similar to those found on site S3 (naked barley and emmer wheat) whereas the bone material represents domesticated animals such as pig, cattle and dog, and wild animals such as beaver, wild boar, red deer and water vole. Many fish and bird bones, including wild duck, were identified as well (see Prummel et al. 2009). The bone material from the old excavations, also analysed as part of the New Swifterbant Project, reveals other species such as otter and presumably sheep and/or goat. This combined research reveals that pigs were much more often consumed than cattle, and domesticated pigs were preferred to wild boars. If sheep or goats were present, it would only have been in very small numbers (Prummel et al. 2009: 31). Two bone tools were published as well, a spatula and a fragment of a worked antler (possibly an axe fitting or haft). For a full report on the stone and flint artefacts, from the old and the new excavations, see chapters 4 and 5.

During the use-wear analysis on flint artefacts conducted by Bienenfeld (1985), undertaken to reconstruct the subsistence activities and to tackle the problem of occupation continuity, a total of 127 flint artefacts were analysed. On 46 of the selected blades and retouched tools, traces indicating soft plant and hide processing along with wood, bone or antler working could be identified. This suggests that a diverse range of daily activities was carried out at the site including animal butchering, hide and plant processing, and wood working (ibid: 203-205). For more details on this research and of more recent conducted use-wear analyses see chapter 5, section 5.5.

The human remains consisted not only of nine skeletons but also of several isolated finds of skeletal remains, mainly teeth. The graves are located on the highest part of the levee, are all aligned with the creek and have a similar orientation suggesting the old graves were still discernible at the surface when new graves were dug. The human remains from the graves were found between -5.32 m and -5.60 m NAP (Meiklejohn & Constandse-Westermann 1978), thus extending 10 cm deeper than the cultural layer. In some of the grave pits, small potsherds and/or flint artefacts, similar to the material of the occupation layer, were found. The interpretation of these loose artefacts has been disputed. The debate, whether they are grave goods or accidental grave filling, is in my opinion resolved in favour of the latter (see Lanting & Van der Plicht 1996). Still, the on-going debate in the 1970's was presumably the reason why Meiklejohn and Constandse-Westermann (1978) published only the obvious grave goods.

The full skeleton of grave I was recovered by Van der Heide in 1964 and has no associated grave goods[24]. Graves II, III and IV were also discovered by Van der Heide in 1964, but at that time only the skulls were recovered. The remainder of these complete skeletons was excavated in 1971, all without associated grave goods. The skull of grave V was clandestinely removed [25] after being partially uncovered during geological work in the winter of 1971-1972. The skull was sent back several months later to the BAI, unfortunately damaged during transport. In 1975, the rest of grave V was excavated. Noteworthy are the amber beads found near the woman buried in this grave (see below). Located directly next to grave V, was grave VI, a complete skeleton with no clearly associated grave goods[26]. It remains unclear as to whether grave V was buried in the same grave pit as grave VI, or was dug into the top of it. Both graves VII and VIII were partially recovered in 1975 with the remainder excavated in 1977. They presumably represent two complete bodies, even though no skull could be retrieved from grave VII. Both graves were without associated grave goods (Van der Waals 1977: 13-14, Meiklejohn & Constandse-Westermann 1978: 61-70). Grave IX is considered to be the most spectacular of all burials at the Swifterbant cluster. Not only is it the best preserved; it also contained the richest mixture of grave goods recovered from and around this man's body (see below). The grave was discovered during the excavation of grave VII and could be interpreted as a double burial with the latter. A series of isolated skeletal remains recovered on site S2 contained c. twenty teeth fragments in combination with fragments of a thighbone, an upper arm bone, a heel-bone, and a vertebra (Meiklejohn & Constandse-Westermann 1978: 70-73, 87).

The graves of site S2 are seen as a genetically closed linked group. Dental anomalies, often seen as heritable, suggest kinship whereas age and sexual dimorphism suggest an extended family group. Even more, the contemporaneity of the graves is implied by their clear alignment and the uniformity of the burial positions. The strong wear rate of the molars was also observed with many individuals (Constandse-Westermann & Meiklejohn 1979, Raemaekers et al. 2009).

Finally, it remains open for discussion whether the graves predate the occupation period of site S2 or are

24 According to Deckers (1979: 153-154) a flake was found during work on the skeletal material from grave I.

25 For a further discussion on this skull see catalogue section 1.2.2.

26 According to Deckers (1979: 153-154) a flake and a blade with use traces was found during work on the skeletal material from grave VI.

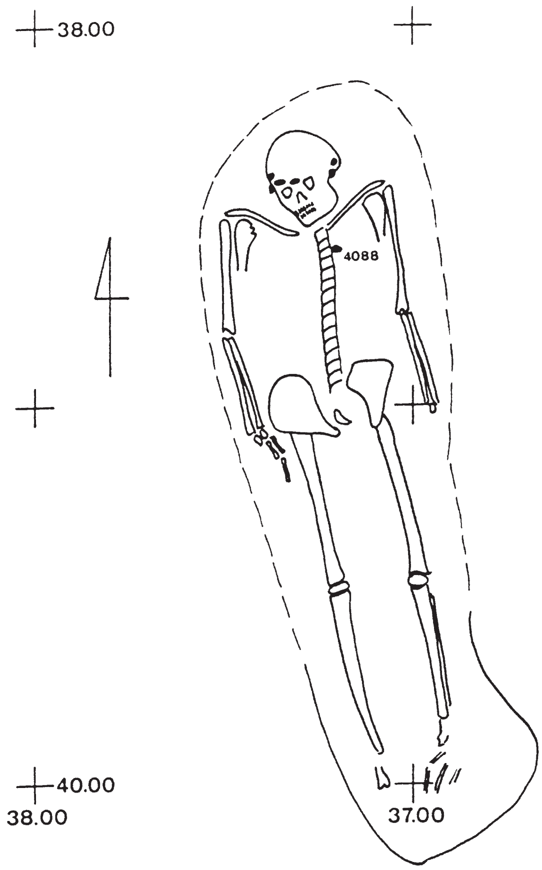

Figure 2.6 Adult male in grave IX at site S2. Adapted from Kielman 1986, fig. 15b.

contemporary (see section 2.8.2). During the excavations it proved impossible to see whether the graves were dug into the occupation layer. The available radiocarbon dates suggest that the graves are older than the settlement but there is a clear ageing effect in the dates resulting from fresh water reservoir-effect (Lanting & Van der Plicht 1996). Although it is clear that the dates of the graves are too old, they cannot be corrected. The chronological relation between graves and settlement therefore remains unsettled on the basis of radiocarbon dates.[27]

A total of 27 ornaments was recovered (Kielman 1986: 16-24). The most remarkable are those from grave IX. The man was buried with five amber ornaments on his forehead and a perforated boar's tusk[28] on his chest (figure 2.6). A stone pendant recovered near the body's right ear might have been part of the head ornament as well. Grave V also yielded several ornaments. Near this woman's neck seven amber beads and pendants were recovered; near her pelvis one more amber bead was found. The skull presumably belonging to this woman was also accompanied with three amber beads and pendants. The other ornaments could not be ascribed to specific graves with 100% certainty. Two amber pendants, one amber bead and an unfinished stone pendant could belong to grave V or VI while one stone bead might belong to grave VIII or IX. Two amber beads and two amber bead fragments were found scattered over the site.

2.7.3 Site S3, trench S5, and trench S6 (parcel G43)

Research area

This site was discovered in the course of the systematic geological investigation of the ditch slopes and was first examined during the excavation of a trial trench in 1972 (figure 2.7 and table 2.3). According to the excavation reports a trench of 5x30 m[29] was dug and excavated in squares of 1.25x1.25 m. Work was not completed until 1973 because the occupation layer was much thicker than expected (Van der Waals & Waterbolk 1976: 12). The research team presumed that the layer would be as thick as on site S2 but it turned out to be 0.60-0.75 m, the thickest from all Swifterbant sites. Because of this and the good organic preservation conditions of this layer[30], the site was chosen for integral excavation. In 1974, a second trench of 6x30 m was opened. It appears that a part of this trench had already been excavated in 1973 but it remains unclear exactly how much. Research continued in this trench during 1975 but could not be completed fully due to a collapse of the section. In that same year excavations started in a third trench. Because the dimensions mentioned in the excavation reports do not correspond with the figure in Van der Waals (1977: 16) it remains unclear whether only a part of 6x20 m was excavated or the whole 6x30 m trench. In 1976, research in this third trench was concluded. The last campaign was conducted in 1977. At that time a large trench of 5x19 m was excavated perpendicular to the already excavated area. At the end of this trench an area of 9x10 m was also excavated in that same year.

Trench S5 is an integral part of site S3; it is merely the part of the trench which ran into the creek. Because neither the RIJP nor the BAI used drainage, some parts of the Swifterbant area were unavailable for excavation due to the high groundwater level. Only in 1975 did dry weather conditions allow the large trench to be dug in the creek alongside site S3 (Van der Waals & Waterbolk 1976: 12).

27 Contrary to de Roever (2004: 25).

28 The precise nature of this tooth is unknown. Meiklejohn & Constandse-Westermann (1978: 70) call it a boar's tusk; Kielman (1986: 17) identified the artefact as a pig's tooth, which might be an incisor or molar as well.

29 The dimensions of the 1972 trench given by Van der Waals (1977: 15) are smaller (4.5x20 m) because the pit was stepped when it was deepened so that a smaller area was excavated.

30 Site S3 still has the best organic material conservation conditions of all the sites within the Swifterbant cluster.

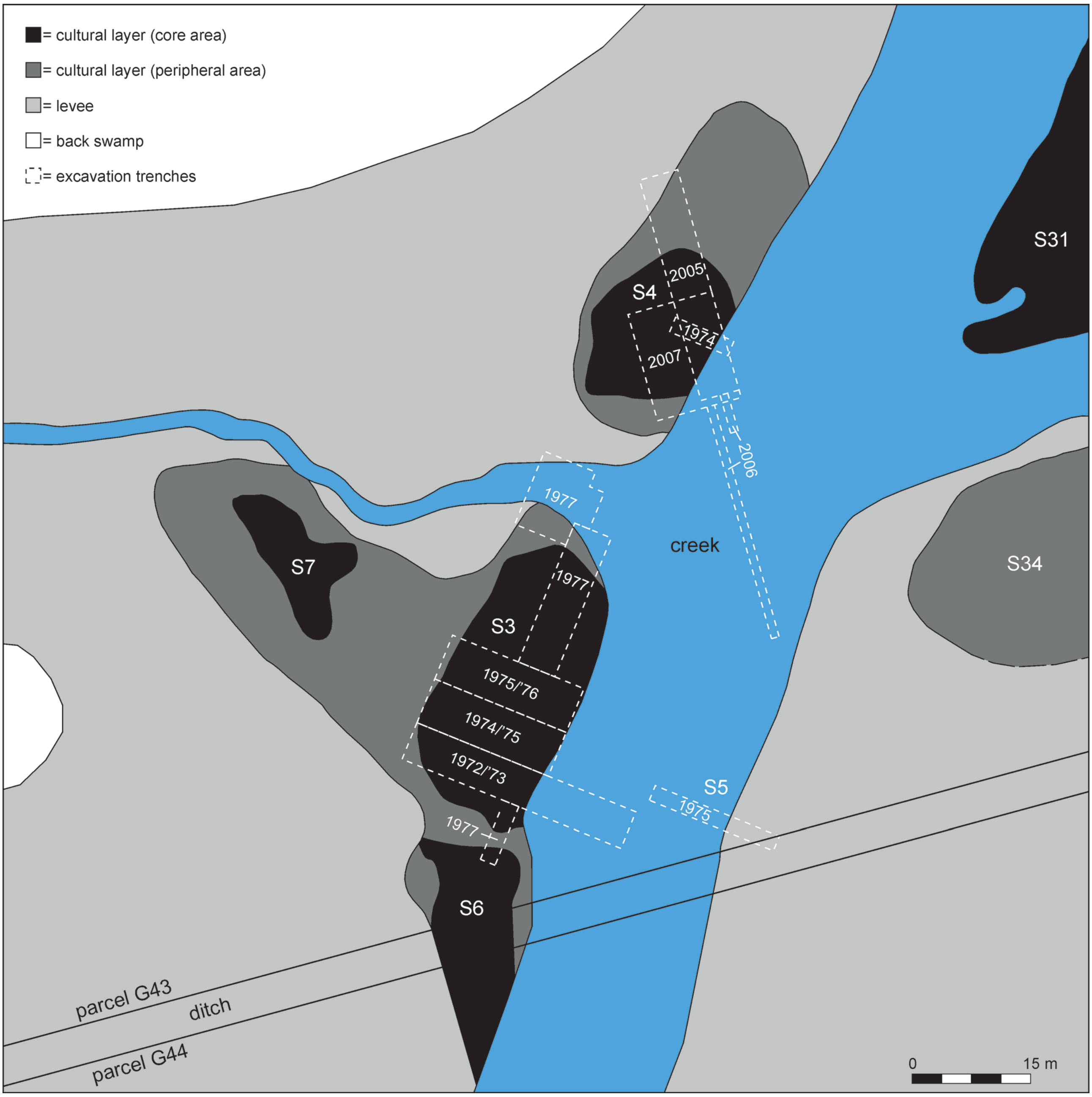

Figure 2.7 The different excavation campaigns at sites S3 and S4. Adapted from Fokkens 1978, fig. 16.

The trench presumably was 2x17 m[31] and was situated 1 m to the southeast of site S3.

The situation for trench S6 is somewhat different. The area to the south of site S3 is characterised by a grey peripheral zone separating two black occupation areas, that of site S3 and that of site S6 to the south (figure 2.7). The small core region of site S6 (see section 2.6) was discovered in 1972 and partially excavated in 1977 (Deckers et al. 1980). The trench, also named S6, runs from within the cultural layer of site S3 to the cultural layer of site S6, crossing the peripheral area. Trench S6 was small, 2x8 m with an extra square metre at the north-western corner to expose a piece of antler and some pottery. The detailed coring campaign by Fokkens (1978: 19) indicated that the dark layer of site S6 continues on parcel G44 for at least 10 m.

Geology

The dark occupation layer extends over an area of 20x38 m and fades out to the margin of the site. The lower part of its soil profile is built up of thin, irregular lenses of different soil types and compositions such as sterile clay, clay intermixed with organic and charred material, or

31 Again, Van der Waals (1977: 22) reported different dimension than the excavation drawings, being 3x14 m along the 10 m line.

white ash. Examination revealed that part of the levee and occupation remains were eroded by and re-deposited in the creek, only to be covered by sterile clay and a second habitation phase in a later period. Apparently, this second habitation phase shifted to the west of the levee. These observations made Van der Waals (1977: 17) conclude that the first occupation phase was characterised by repeated flooding, whereas the second occupation phase gave evidence of a more stable environment as no clay lenses could be detected throughout this layer. Even more, the bundles of reed and twigs recovered from the layers were interpreted as an indication of wet living conditions (Deckers et al. 1980).

As for site S2, the discovery of the hoe-field on site S4 (see section 2.7.4) resulted in renewed research at site S3. The analysis of an old soil profile of site S3 revealed great similarities to the soil profile of site S4. The same type of disturbance as seen on sites S2 and S4 was attested at site S3 as well. Therefore it is presumed that the same type of activity, i.e. a hoe-field, was present as on site S3 (pers. comm. D. Raemaekers 2012).

Archaeological features and finds
The researchers uncovered several types of features such as hearths, stakes and posts. Different types of hearths were discovered especially in the second habitation layer. Some were round to rectangular patches of white ash of burnt bone, two were shallow pits encircled by charcoal and others were built up of clay floors that were repeatedly reconstructed one on top of the other at roughly the same location. The general lower position of site S3, compared to site S2, may have made the site more vulnerable to wet or damp living conditions. The bundles of reed and twigs present at the site were therefore interpreted as being used to raise, isolate, and dry out the occupation area. As a consequence, the hearths needed to be constructed on clay floors (Deckers et al. 1980).

A total of c. 650 stakes and posts were recovered at the site as well.[32] Their diameters range from c. 6 cm to a maximum of 11 cm. Most of them were pointed and directly driven into the ground without the use of a post hole. A row of fourteen stakes, similar to that of site S2 and with the same distance between the stakes, was discovered in the 1972/1973 trench (Van der Waals 1977: 18). Within the maze of approximately 650 stakes and postholes, de Roever (2004) reconstructed the outline of a house. It is not a clear-cut ground-plan of one single house; within the tangle of stakes and postholes two more or less clear lines with four or five transverse lines create an rectangular area of c. 4.5x8 m. De Roever (ibid: 34) suggested an interpretation as a house repeatedly being repaired on the same spot.

Deckers (1979: 147) counted 811 flint and 186 stone artefacts. He mentioned that there are 'indications of polished flint axes' on site S3 (ibid: 162). The presence of stone artefacts is suggested by Van der Waals (1977: 21) who recorded the presence of 'very few fragments of a *Breitkeil*'. Unfortunately, none of the publications is more precise. The number of potsherds is unclear. Deckers (1979: 147, 162) mentioned 1738 potsherds; de Roever (1979: 16) gave a total of 1250, of which there were 165 rims and 9 bases, and Raemaekers (1999: 32-33) mentioned a sample of 400 pieces.

All human remains found on site S3, and in trenches S5 and S6, are isolated finds (Meiklejohn & Constandse-Westermann 1978: 73-74, 87). These remains include a jaw, a tibia, and approximately fourteen teeth fragments. Unfortunately the authors did not specify the precise location of these finds, whether they were discovered on site S3 or in trenches S5 or S6. In their report, Clason and Brinkhuizen (1978:72) mentioned the tibia as part of the discard found in the small creek north of site S3. They pointed out that the shaft was covered with numerous cut-marks and that both epiphyses were partly cut and partly gnawed away. Indirectly, they suggested that cannibalism was involved. Meiklejohn and Constandse-Westermann (1978: 88) on the other hand reported several more bones with cut-marks, both from graves and loose finds, and although they do not totally discount cannibalism, an interpretation as defleshing of skeletons or loosening the joints is more conceivable.

The animal remains from site S3 and trench S5 are not studied separately but as a whole by Brinkhuizen (Brinkhuizen 1976, Clason & Brinkhuizen 1978) and by Zeiler (1986, 1987, 1997). Both species and age determination are analysed to determine diet, subsistence strategy and the season of occupation. Several large and small mammals were present such as pig and wild boar, cattle, red deer, otter, and beaver, a few sheep or goats, some dogs and horses, and one or two elks, polecats and bears. From fox, wild cat, common seal, and mole, only one bone was recovered. Among the birds, remains of ducks were the most abundant, especially of mallard; less frequent were shelduck, pochard, tufted duck, goose, mute swan, white-tailed eagle, carrion crow, and cormorant. One artefact of bone was produced out of an ulna of a crane. Fish species consisted of pike, bream, rudd, roach, tench, catfish, common eel, perch, ruffe, flounder, thin-lipped grey mullet, sturgeon, and salmon/sea trout. The people of Swifterbant did not solely rely on their domesticated animals but exploited as many wild food resources. Some animals, like beaver and otter, were presumably mainly hunted for their fur, although their meat was consumed as well. Zeiler stated that the site was occupied at least from March to September and to a lesser extent in autumn and winter.

32 Deckers et al. (1980: 137) even mentioned 750 posts and pegs.

For further and more detailed information I refer to the above mentioned publications.

Among the numerous animal remains, a total of 158 bone tools, including fragments, were recovered (Bulten & Clason 2001).[33] The inhabitants of Swifterbant used bones of domesticated and wild mammals, birds, fish, and red deer antlers. The finds on site S3, whole or fragmented, include four T-shaped antler axes, six shafted antler axes, two socketed bone axes, one unsocketed bone axe, three bone chisels, 69 bone awls, and seven chisels and three knives made of lamellae of wild boar tusks.

A large number of ornaments were found scattered all over the site. Of the 68 ornaments 32 were made of amber, 18 out of stone, 16 out of animal tooth and one out of animal bone. For the 16 perforated teeth four tusks (three from pig/boar and one from otter) and twelve incisors (six from cattle, three from boar, two from horse and one from dog) were used. Two more ornaments are quite special; one boar's tusk was not perforated but notched, presumably for better attachment, and one vertebra of a catfish was used as a bead (Van der Waals 1976, Kielman 1986). Van der Waals (1976) also mentioned a pendant with an engraving of an animal face manufactured on a shark's tooth. Unfortunately, this was an elaborate student's hoax.

To establish a better insight into the wood species present at the site and their specific uses, pieces of wood, charcoal and bark were sampled on site S3 over an area of 39 m² and analysed along with the stakes and posts of the site and trench S5. Casparie and his team (Casparie et al. 1977: 37-42) stated that most of the wood was brought in by the inhabitants. Apparently they had a preference for small trees and branches as the average diameter of the round wood is as small as 5.13 cm. The high number of alder stakes or pegs presumably indicates a natural dominance of these species in the forest, whereas the low values of oak might represent a selective gathering by the inhabitants, as the pollen analysis suggests that oak was also frequently present in the surrounding area (see below trench S5 and section 2.7.6). As pegs of birch, hazel, ash, willow, and wild apple also occur, Casparie concludes that there is no clear indication for a preference for specific wood types. It should be mentioned that the pointed ends of the pegs are not all man-made; gnawing marks of beavers suggest that some pegs could have been part of a dam.

Van Zeist & Palfenier-Vegter (1981) studied seeds, fruits and other macroscopic plant remains, excluding charcoal and non-carbonized wood. Systematic sampling for palaeobotanical examination started in 1973. All soil dug away in 10 cm layers and per m² was sieved through two sieves with meshes of 2 and 1 mm. This method appeared to be too time consuming and resulted in many more samples than the laboratory could analyse. From 1974 onwards, it was decided to sieve only through 2 mm sieves. As most seeds wash through this, another system had to be chosen for palaeobotanical research. Analysts settled on unprocessed soil samples of 1 and 3 litres of which some were chosen for their richness of seeds (Casparie et al. 1977: 46). Van Zeist & Palfenier-Vegter (1981: 111) believe this method is representative for the variety of plant species on the site. For a description of all seeds and fruits see Van Zeist & Palfenier-Vegter (1981).

When the authors described the reconstruction of the vegetation, they assumed that most of the seeds, fruits, and wood remains originated from herbs, shrubs or trees which were present in the vicinity of the settlement. They claimed that on the site the deciduous woods must have comprised small trees and that in the near vicinity a full grown deciduous wood land existed. Besides remains of hazelnut, crab apple, hawthorn, rose-hips and blackberries evidence of cultivated cereals was found. The remains consisted of a large amount of six rowed naked barley, a small number of emmer wheat grains and one grain from bread wheat[34]. Remains of other edible or non-edible wild food plants, such as water-lilies, were recovered at the site as well. The presence of a bundle of elm twigs is interpreted as animal fodder, although other explanations cannot be ruled out. Other aspects of the analysis of seeds and fruits, such as the intentional or accidental arrival on the site, the natural changing landscape over time or its relation to habitation, and this habitations' nature, can be found in Van Zeist & Palfenier-Vegter (1981), Van Zeist (1974) and Casparie et al. (1977).

An analysis only performed on this site is the microscopic examination of coprolites. Forty-four samples of c. 1 g have been analysed and tested for the presence of worm eggs. Most of the samples contained only one species of worm eggs; four samples contained two or three different species of worm eggs. Most occurring species are *Trichuridae*, *Opistorchidae*, and *Fasciolidae*. For more specifics, I refer to De Roever-Bonnet et al. (1979).

Archaeological features and finds from trench S5

As the creek filling was repeatedly washed away, not many artefacts were left to be recovered. Only some potsherds, a T-shaped antler axe, a fragment of a worked, wooden shaft and a number of stakes were reported (Van der Waals 1977: 22). In 1979 Casparie and his co-researchers

33 The number of artefacts differs in Bulten (1988) and Bulten & Clason (2001). Because of the different tool typology it is not possible to determine the extent of the discrepancy. Therefore the information was retrieved from the most recent article.

34 The problem of local agriculture and the use or purpose of cereals as main or additional food source to a diet of predominantly fish and meat is addressed by Van Zeist & Palfenier-Vegter (1981) and other researchers (Clason & Brinkhuizen 1978, Cappers & Raemaekers 2008).

(Casparie et al. 1979: 42) had analysed a great deal of the wood samples and stakes on site S3, and trenches S5-S6 and reported a few more objects for trench S5. One is an upper part of an axe handle of ash wood, the other an upper part of a shaft or haft of hazel wood[35]. They also mention a fragment of a 2 cm thick willow stick in the hole of an axe of a stag horn. Bulten and Clason (2001) described 14 whole or fragmented finds of bone and tooth tools, including the already known T-shaped axe; the other tools are three waste fragments of T-shaped axes or hammers, two shafted antler axes, and two bone awls.

Archaeological features and finds from trench S6

The little information from the excavation notes describes a small hearth, a T-shaped antler axe and some pottery. The number of flint artefacts is limited to 30. As there is currently no way to establish which artefacts belonged to the peripheral area and which to the black core regions of either site S3 or site S6, all the material is included in trench S6, thus analysed in bulk with site S3. Still, the flint artefacts are shown separately in table 3.8 in appendix 3.

Pollen analysis

A soil sample for pollen analysis was taken out of the sediments in the creek of trench S5. The resulting diagram shows the environment shortly after the end of the occupation[36] at c. 5200 BP. At that time, the natural environment was dominated by reed vegetation and the creek near site S3 was almost totally filled up. After about 5000 BP, the gully filled up with reed-sedge peat and a woodland vegetation of mainly oak, hazel, and ash started to establish on the levee with narrow alder zones on the side (Casparie et al. 1977: 33).

2.7.4 Site S4 (parcel G43)

Research area

This site was discovered in the coring campaign of 1972 at approximately 60 m north of site S3. In 1974, a small trench of 2x8 m was dug from the side of the creek to the centre of the site[37] (Van der Waals & Waterbolk 1976: 12-13, Deckers 1979: 159) (see figure 2.7 and table 2.3). According to the excavation report the trench is only 20 m to the northeast of site S3. In this report a trial trench of 1x10 m is also mentioned which was excavated by a group of amateur archaeologists. At both sides of this trench, two strips of 2x10 m were cleared of all ground covering the cultural layer for practical reasons. The trench was oriented over the shortest axis of the cultural layer, from the periphery to the centre. The cultural layer on site S4 was about 30 cm thick and extended over an area of 22.5x29 m.

New research at site S4 started in 2005 and continued in 2006 and 2007. The trench of the 2005 campaign (5x25.5 m) was positioned perpendicular to the levee and ran from the levee into the back swamp. The area was excavated in 10 adjoining strips of 0.5 m divided in spits of 50x50x5 cm, while 20% of the spits were sieved (strips 8 and 9). The back swamp was mostly examined by machine (Raemaekers et al. 2005). In 2006 research continued in this trench as only five layers were excavated in 2005. The cultural layer appeared to be thicker than expected, up to 40-50 cm. The remaining four layers were completed in 2006. That year the research was partially aimed at the child's grave discovered in 2005, and partially at the extension of the trench into the creek. The small extension was excavated manually and resulted in an additional three layers whereas the large extension into the creek was excavated by machine. In 2007 a second trench, adjoining the first trench to the west, was partially excavated. Strips of 50 cm wide and 4-5 m long were dug in an area of 5x8 m. Most of these strips were deepened to 40-45 cm. Research in this year revealed the presence of a hoe-field below the occupation layer (Raemaekers et al. in prep.). As an addition to that campaign, a small coring exercise was conducted to map the extent of the hoe-field.

Geology

Van der Waals (1977: 24) mentioned a thin, basal occupation layer of c. 0.06 m thick covered by a band of clay. This occupation phase was characterised by repeated flooding and erosive episodes. Above the band of clay, a second occupation phase was recorded approximately 0.30 m thick with clear erosive and flooding phases in the lower parts of the layer. To the west, a third, thin layer of 0.05 m was separated from the main occupation level by a clay band. In contrast to Van der Waals' description, Deckers (1979: 159) spoke only of two layers and stated that the find layer in the excavated area[38] was largely disturbed leaving only an area of 2x4 m *in situ*.

This image is not contradicted by the new research, only clarified and supplemented. The 2007 campaign revealed the thin, basal occupation layer of c. 0.06 m thick to be part of a hoe-field. To be more precise, it was worked into a hoe-field. The band of clay was also clearly visible and separated the first occupation layer from the second,

35 It is unclear which of these two was mentioned by Van der Waals (1977: 22).

36 Casparie et al. (1977: 33) referred to this period as the Calais III transgression. In the modern classification the Calais - Duinkerke system has been abandoned; all layers are now part of the Wormer Member of the Naaldwijk Formation. The Almere layer, Zuiderzee layer, IJsselmeer layer and the IJe layer are in the modern classification part of the Walcheren Member of the Naaldwijk Formation (Ebbing et al. 2003).

37 The trench dimensions (3x7 m) given by Van der Waals (1977: 23) are incorrect.

38 Although Deckers spoke of a 2x8 m trench, the figures in the article show one of 2x9 m of which three square metres are left blank. This might indicate that the working pit was larger than the actual excavated area.

thicker occupation layer over the whole site. This thicker layer is interpreted as the main occupation phase. The coring campaign indicated that the clay layer, and thus possibly the hoe-field, covered an area of at least 200 m², and possibly even extended over an area of 1600 m² (Woltinge & Schepers in prep.). This research did however not reveal the presence of a third layer. What is clear is that at least five different tillage phases can be attested, ranging from before the first 'visible' occupation phase, until after the end of the main occupation phase. Even more, ongoing research by Huisman et al. (2009) and Raemaekers suggests that hoe-fields occurred on sites S2, S3 and S4. It may even be that other levees were used as well (pers. comm. D. Raemaekers 2012).

Archaeological features and finds
The features in the 1974 trench include a pole, a hearth and a concentration of hazelnuts to the west of it. Most invasive is a large disturbance of about 4 m² in the middle of the trench (Deckers 1979: 159, 164). Recently discovered features are a child's grave and two more wooden poles (Raemaekers et al. 2005, Raemaekers et al. in prep.).

Deckers (1979: 161-165) reported 244 flint artefacts[39] of which two were found in the lowest cultural layer, i.e. the layer worked into a hoe-field. This lowest cultural layer was also practically void of potsherds. According to Deckers, the flint material is vertically evenly distributed through the main occupation layer and forms no noteworthy clusters horizontally. A total of 80 artefacts, blades and retouched tools, were examined for use-wear traces by Bienenfeld (1985). The number of potsherds is 476 according to Deckers (1979: 147) or 467 according to de Roever (1979: 16). There may be an actual difference or one of the two might be a misprint. According to Raemaekers (pers. comm. 2010) it is 467 pieces.

The recent campaigns revealed a large amount of pottery, lithic artefacts, burnt bone fragments, and some charred cereal remains. The hand collected material is already fully studied, whereas the material from the sieved soil is still under investigation. The numbers in section 4.2.4 and 5.2.4 are therefore given with due reservation.

2.7.5 Trenches S11-S13 (parcel H34)

Introduction
Excavations on parcel H34[40] were not started until 1974 when the Museum of Anthropology of the University of Michigan (Ann Arbor) opened three trial trenches on a northeast southwest oriented river dune. The excavations were supervised by R. Whallon Jr. and T.D. Price. The location of the three trenches, designated S11, S12, and S13, corresponded to three small elevations of the dune. Little information is available as all finds remained with Whallon in Michigan after the excavation. Some information is provided by de Roever (2004) who was present during the years of excavation. The size of the dune body, the occupation area, and the three trenches can roughly be estimated by the analysis of figure 1 in the publication of Whallon & Price (1976: 223). It appears that the dune measures c. 175x700 m. The published map indicates that trench S11 was located on the northeast end of the dune and measured approximately 3x42 m. Trench S12 lay in the middle part of the dune and was possibly 3x68 m in size. Trench S13, at the western end, consisted of a long trench of 3x54 m with an extension of 6x12 m. De Roever (2004: 26-27) provides somewhat different measurements for trench S11 (15x35 m), trench S12 (2x60 m), and trench S13 (2x50 m). It is not known if the finds in those trenches are spatially separated from each other by a zone empty of archaeological remains, so it is unclear whether these three trenches represent three different sites. The absence of a dark occupation layer, so typical for the levee sites, makes it impossible to determine the dimensions of these three possible sites.

In 1976 the University of Michigan (R. Whallon Jr.) conducted a second excavation on S11 and published the preliminary research results as a postscript to the 1976 article by Whallon & Price (1976: 229). Whallon wrote: 'The 1976 excavations were restricted to S11 and consisted essentially of two additional trenches of 2 m width parallel to, and on either side of, the 1974 test trench. A short side trench was also extended to the west, perpendicular to the other trenches'. Deckers et al. (1980: 112) mentions two more campaigns on S11, namely the 1977 and 1978 campaign by the University of Michigan. As the material is still in the United States of America and the final publication is pending, this cannot be confirmed. However, de Roever (2004: 26) published some information. It appears that some 7000 flint artefacts were retrieved from trench S11, that the flint material from trench S12 derives from an erosion context, and that the flint assemblage from trench S13 has a Mesolithic character.

Trench S11
This trench is located on a small and low elevation of the dune and is characterised by a spread of archaeological material throughout the old surface layer. This layer seemed to be intact although a very small portion of the A horizon might have been eroded together with the overlying peat. Whallon & Price (1976: 226) indicate that this occupation layer must have extended over an area of at least 35x40-50 m.

The features include shallow hearths, moderately deep pits without charcoal and deep pits with large amounts of charcoal (Whallon & Price, 1976: 226). Whether the latter

39 Bienenfeld (1985: 201) mentions 245 artefacts whereas the number of artefacts still present today is 242.

40 It is not clear when this site was discovered.

two would nowadays be described as hearth pits is, however, unknown.

Of the archaeological remains, Whallon & Price (1976: 227) reported 128 flint tools but gave no detailed information on the rest of the lithic assemblage. De Roever (1979: 16) mentioned 220 potsherds, six of which were rim fragments. The burials on the site, grave I and feature 42, were discovered in 1976. Grave I is a grave pit with a full skeleton; feature 42 is a small oval pit containing at least 17 teeth and several more teeth fragments, all belonging to one individual. From both graves no associated grave goods were recovered (Meiklejohn & Constandse-Westermann 1978: 60-61). Both Whallon & Price (1976: 229) and Meiklejohn & Constandse-Westermann (1978: 40) indicate the different, possibly later and intrusive character of the burials.

Trench S12

Contrary to trench S11, the area of this trench was heavily affected by erosion which washed away the top of the river dune to a depth of well below the B horizon. As a consequence, many of the archaeological finds were rolled or battered and no longer *in situ*. The researchers therefore did not find it worthwhile to investigate the site any further after the initial trench in 1974 (Whallon & Price 1976: 224, 228). Only the flint tools are reported, nineteen in all comprising a trapeze, a backed blade, a borer, four scrapers, a knife, a *pièce esquillée*, a broken point, and nine retouched pieces (ibid: 227).

Trench S13

The heavy erosion characterising trench S12 could also be seen in trench S13, leaving only a part of the subsoil at the extreme southern part of the pit *in situ*. The features displayed a wide variability in form, size and content and are comparable to those in trench S11. The absence of pottery and the presence of flint tools such as a trapeze, a backed blade, a burin, three scrapers, a broken point, and nine retouched pieces point to the Mesolithic character of this occupation area (Whallon & Price 1976: 224, 227-228).

2.7.6 Introduction to parcel H46

Introduction

After the initial find in 1959 of Bell Beaker material on parcel H4 and of pottery on levee site S2, which was presumably found between 1959 and 1961, the first evidence of the Swifterbant culture on a river dune was found on parcel H46. In July or August of 1961 site S21 or S22 was revealed when charcoal filling of a hearth was observed in the lacquer peel (Van der Waals & Waterbolk 1976: 4). Later that summer, more evidence would be found on parcel G42.

The river dune situated on H46 extends over a length of roughly 200 m, making a curve of approximately 90° from a north-south orientation to an east-west one. Both ends of the dune are slightly elevated, intersected by a peat layer covering the lower, middle part of the dune (Price 1981: 82). In the years between 1962 and 1976, four spatially separated areas were excavated, trenches S21 to S24 (figure 2.8 and table 2.3). Trench S21 was located at the far north-eastern end of the dune; trench S22 at the south-western side. Slightly to the east of trench S22, trenches S23 and S24 lay south and north of each other respectively. The dimensions of the settlement area cannot be determined due to the lack of a dark occupation layer. However, there has been an attempt to reconstruct the size of the river dune. The length is c. 200 m while the width varies between 10 and 37 m (de Roever 1976: fig 1).

New research at the dune started in 2008 (see Geuverink et al. 2009, Raemaekers & Geuverink 2009). The explorations were focussed on the identification of well-preserved contexts or refuse layers on the slopes of the dune. The 2008 summer campaign resulted in 113 cores of which 18 contained charcoal. Additionally, a new branch of the Swifterbant creek system was found at a deeper level than usual. The presence of an area of matured clay between the dune body and a newly discovered creek to the north clearly indicated the importance of this creek. The area, interpreted as a 10 m wide levee and designated trench S25, forms a dry bank where the river is closest to the dune. The relative dating of the charcoal samples to the groundwater curve possibly revealed an older habitation phase than commonly attested at the levee sites adding to the value of the river dune and levee. In November 2008 an additional 13 mechanical cores were conducted. This second research confirmed the value of the northern side of the dune where charcoal finds were the most numerous. This area was the focal point of the 2009 and 2010 excavation campaigns.

Some of the human remains found at parcel H46 (see sections 2.7.7 – 2.7.9) were never assigned to any of the specific trenches and are therefore mentioned here. In the 1960's the researchers recovered some loose finds, consisting of a skull, a jaw, and teeth fragments, but could not assess whether they belonged to one or two individuals (Meiklejohn & Constandse-Westermann 1978: 59-60). The lack of a specific date of discovery or any written information might point to their recovery during the ditch slope inspections of 1961. If the material was found during the excavations, this would most likely have been registered.

Pollen analysis

Besides the pollen sample at parcel G43 trench S5, a second pollen sample was taken at parcel H46. The resulting diagram confirmed that in the course of the second half of the Atlantic, the river dunes were covered by mixed deciduous forest of oak, ash, lime, and some hazel. In the

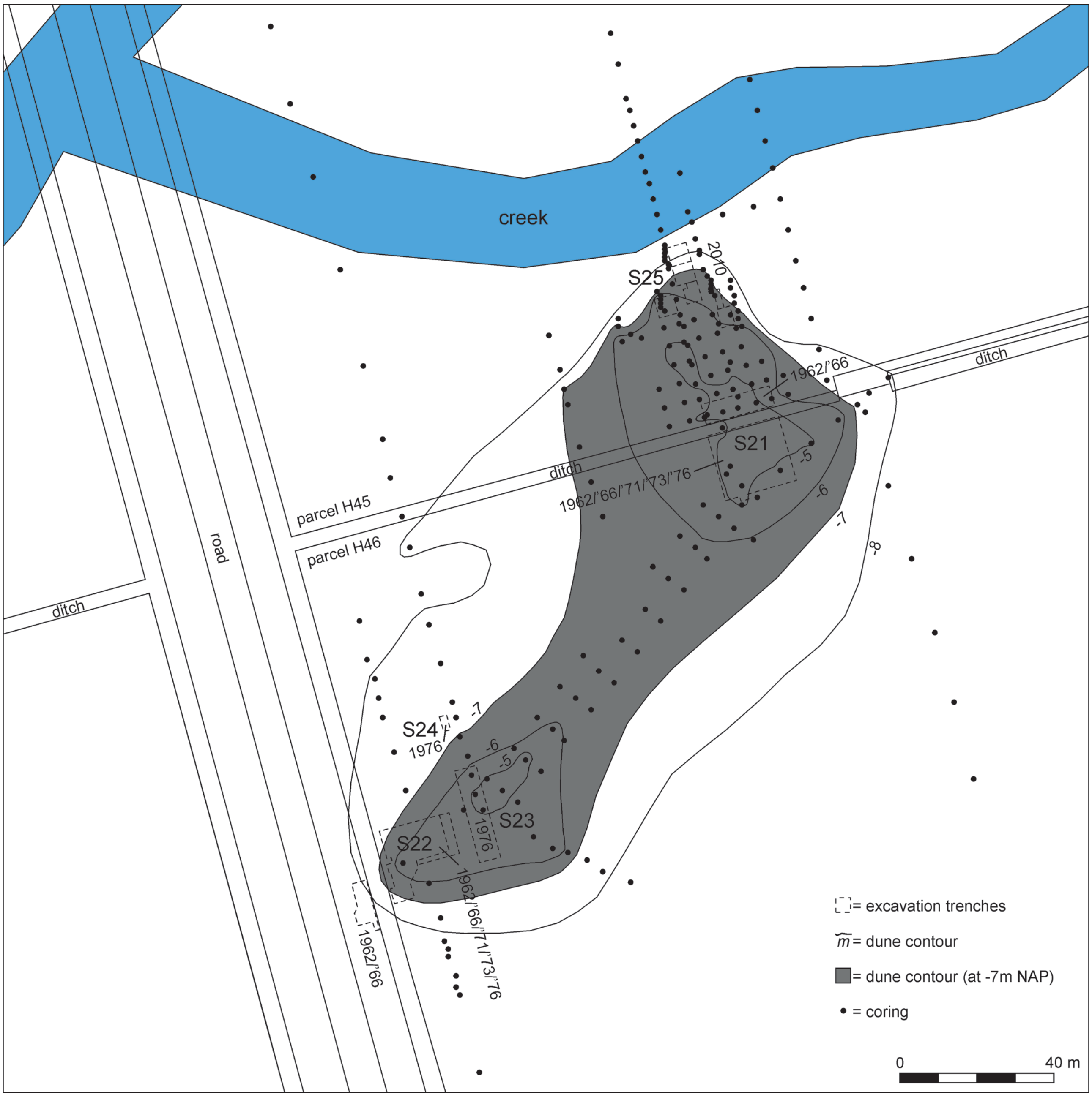

Figure 2.8 The different excavation trenches at parcel H46. Adapted from Raemaekers et al. 2011, fig. 2.

wetter, peaty areas alder was the predominant vegetation and reed-sedge was only limitedly present. Later, the extensive habitats for alder started to disappear as the water level was rising quickly allowing open water to run in the creek near the site over long periods of time. Eventually, the woodland drowned as the water level kept rising and the whole area was covered with Almere deposits (Casparie et al. 1977: 30-33).

2.7.7 Trench S21 (parcel H46)

Research area

The research in the area was not limited to the excavation of trench S21 alone. As the site was discovered during ditch slope inspections[41], the material from these assessments is also of importance to the study. Initially it was presumed that the archaeological remains in the finds bags labelled "*H46 kavelsloot noord*" and "*H46 kavelsloot zuid*", designating the north or south side of the parcel ditch

41 See note 20 and section 3.3.

(see section 3.3), was the material collected in 1961 when the site was originally discovered. This would have suggested that both the northern and southern slope of this parcel ditch revealed archaeological remains. However, seen the sheer amount of flint artefacts recovered from similar white finds bags (see appendix table 3.10), in combination with finds notes[42], this is most likely not correct. The possibility exists that the material originates from the early excavations conducted between 1962 and 1966 by van der Heide (see below). Alternatively, this would mean the material from the ditch slope inspections is not yet identified.

In 1962 the first trail excavation of a Swifterbant site was made on parcel H46 by the RIJP. Two trenches were opened; one on the north-east side of the river dune (later designated S21), the other on the south-west side (later designated S22; see below) (see figure 2.8). Van der Heide (1966a, 1966b) mentions 'two pits' but does not distinguish one from the other and he is not precise about the nature and number of archaeological remains found on H46[43]. It is also unclear whether he refers to two separate excavation areas or to two trenches on one location.

Excavation reports and drawings suggest that there were two areas of 5.5x18.5 m for trench S21. The area to the north of the parcel ditch was designated trench segment 1[44]; the other to the south was designated trench segment 2. During a second campaign in 1966[45], trench segment 1 was completely excavated. For trench segment 2 the articles and excavation drawings contradict each other. The only certainty is that research could not be concluded. It remains unclear exactly how big the area was, whether it was enlarged or not and how much of it was excavated. In 1971 and 1973, the still open area of trench segment 2 was revisited by Van der Waals and his team. The two campaigns resulted in an excavated area of 15x18.5 m. This area was made up of three even sized trenches, including the remainder of trench segment 2, and trench segments 3a and 3b. Finally, in 1976, the University of Wisconsin (Madison) focused their field work on this parcel. Before opening two new trenches, S23 and S24, the research team excavated an unfinished part of trench segment 3b, namely a grave which could not be excavated fully in 1973 due to its location in the trench section. The remainder of the grave was recovered by the Wisconsin team, under supervision of T.D. Price by making a small extension at the south end of the pit of 1.5x1.5 m (Price 1981: 85).

Geology

The top of the river dune in trench S21 was eroded, resulting in the secondary positions of the artefacts and the partial destruction of features such as hearths. Between the dune sand and the overlaying Almere deposits, a 2-5 cm thick light-yellow erosion layer of sand was detected. Underneath, the soil profile was characterised by a brownish-grey A horizon, a darker grey to brown B horizon and a yellow C horizon. The complete soil horizon was only found on the outer rims of the trench, i.e. the slopes of the dune. The top of the dune presumably must have been at c. -4 m NAP.

Archaeological features and finds

The recorded features consisted primarily of hearths and graves. The hearths could be distinguished from the surrounding sand by their more or less black filling with charcoal, and their round shape with basin-like cross sections; diameters varied between 0.50 and 1 m whereas depths averaged between 0.40 and 0.60 m (de Roever 1976: 211). These features can presumably be interpreted as hearth pits. The graves were long oval, grey pits with a depth of c. 0.60 m located below the erosion layer in sands of varying light and dark colours.

Some of the archaeological finds were retrieved from the erosion layer; others were still *in situ*, evenly spread throughout the cultural layer and stratigraphically not separated. De Roever (1976: 215) mentioned flint artefacts such as blades, Late Mesolithic points[46], scrapers, small knives, borers, burins, and a Neolithic knife, together with stone tools such as quartzite flakes, fragments of hammerstones and other small pieces of stone. A total of forty potsherds were also recovered (de Roever 1979: 16).

During the 1962 and 1966 excavations, Van der Heide discovered three burials in oval grave pits of which grave V was fully recovered. From graves III and IV only the skulls were recovered; the remaining parts of these skeletons were collected in 1971. All three graves contained full skeletons without any associated grave goods. In 1966, a grave pit was discovered containing only a badly preserved skull. This grave was recorded as feature number 744. Grave X, recovered in the 1960's[47], only contained fragments of one or two teeth. The full skeleton of grave XI was discovered in 1973 and retrieved in 1976

42 The notes recovered from the finds bags containing flint artefacts all roughly indicate the same, that the material is checked or not-checked by van der Waals, with a date around 13.06.1968. This implies the material was excavated before 1968 and possibly by someone other than van der Waals. Possibly the material was examined as a preparation for van der Waals' research in 1971.

43 Van der Heide (1966a) mentioned some potsherds, flint artefacts such as blades, microliths, scrapers and arrowheads, hearths and a burial.

44 In the original publications the term 'working floor' is used.

45 In one of his annual publications Van der Heide (1965) mentioned that "research continued" at parcel H46. It is, however, unclear whether these are excavations or not. The same applies to some of the other reports published between 1959 and 1970.

46 Late Mesolithic points such as a '*feuille de gui*' and some small trapezes.

47 The precise date is unknown.

without associated grave goods. Isolated human remains at this site comprise a lower jaw with associated teeth, the base of a skull, and three loose teeth distributed over two find spots (de Roever 1976: 214, 218-219, Meiklejohn & Constandse-Westermann 1978: 50-55, 87).

2.7.8 Trench S22 (parcel H46)

Research area
The same excavation technique as on S21 was applied to S22. The excavation areas were located at both sides of the ditch. As for site S21, the material was put in several white finds bags labelled "*H46 bermsloot oost*" and "*H46 bermsloot west*", designating the east or west side of the shoulder ditch (see section 3.3). Again, it is unclear whether these originate from the ditch slope inspection of 1961 or from the trial excavations between 1962 and 1966, yet their amount would suggest the latter.

Trench S22 was part of the first trial excavation in 1962 at Swifterbant, just as trench S21. Two areas of irregular shape, trench segment 4 (c. 14x5 m) and trench segment 5 (c. 17.5x9 m) [48], were dug at the south-western end of the dune (see figure 2.8). The information which Van der Heide (1966a, 1966b) provided is far from complete; therefore I can only assume that during the 1962 and 1966 campaigns, the team worked both in trench S21 and S22. The BAI excavated at the site for two more years, in 1971 and 1973, during which they enlarged trench segment 5 to the east with three more excavation areas, namely trench segments 6a, 6b, and 6c. Segments 6a and 6b cover an area of c. 9.5x11.5 m; segment 6c covers an area of 3x12.5 m. Apparently, the BAI could not complete their fieldwork as the University of Wisconsin (Madison) excavated the remaining part of trench segment 6c in 1976 (Price 1981: 81-82). It is not mentioned how much still needed to be excavated but an extension of 1x12.5 m was presumably not fully excavated.

Geology
The soil profile in this trench is comparable to that of trench S21. The E, B, and C horizon are truncated at the top of the dune. The A horizon with thin, distorted, lenses of white sand complements the soil profile along the slopes. The erosion also affected the features nearest to the top of the dune, truncating the upper parts of hearths and graves, and covering the whole site with a thin, yellow, sandy layer (de Roever 1976: 215).

Archaeological features and finds
The described features are hearths and graves. The hearths are described as black concentrations in the lighter B horizon, rich with charcoal and burnt artefacts whereas the homogeneous, light-grey sand of the graves indicate that they must have been dug after the formation of the soil horizons on the dune. Even more, they were probably dug after the last occupation phase of the site, for example during the Neolithic habitation of the levee sites (Price 1981: 100-102).

One of the most exceptional archaeological finds was found at the bottom of hearth feature 4. The artefact, a fragment of a mace-head which is a type of stone tool also known as '*Geröllkeule*' or '*Durchlochten Keulenkopfes*', was burned (Van der Waals 1972: 165, Price 1981: 85)[49]. Beside this mace-head 10 other stone artefacts, along with 428 flint artefacts, 54 pieces of charcoal, and roughly 500 potsherds were recovered. Among the flint industry are 1 lancette point, 1 scalene triangle, 1 borer, 7 scrapers, and 45 worked pieces (de Roever 1976: 217, de Roever 1979: 16, Price 1981: 85).

The human remains include six full graves and one isolated find. In 1966 graves I and II were recovered, in 1971 graves VI, VII, VIII and IX. Grave I consists of a round pit with the remains of a skull and associated jet pendant. Contrary to de Roever (1976: 219), Meiklejohn & Constandse-Westermann (1978: 55) find it improbable that an isolated tooth, found near burials I and IX, can be attributed to this grave. Grave II yielded another skull, presumably from an oval grave pit and without associated grave goods. Both graves VI and IX contained complete skeletons, each found in an oval grave pit without associated grave goods. Special attention should go to graves VII and VIII, a double burial found adjacent to grave I, in a single, broad, oval grave pit. Although no grave goods were associated with the female skeleton of grave VII, two transverse arrowheads were mentioned in association with the male skeleton of grave VIII (de Roever 1976: 217-219, Meiklejohn & Constandse-Westermann 1978: 55-58). However, recent research questions the typological designation of these two artefacts (see chapter 4).

2.7.9 Trench S23 (parcel H46)

Research area and geology
This trench was excavated by the American team of the University of Wisconsin (Madison) as part of the 1976 campaign on H46 and consisted of an area of 6x25 m, of which 24 m^2 were not excavated (see figure 2.8). Even though the location of the trench was carefully chosen to obtain *in situ* archaeological remains and undamaged occupation areas on the largely eroded dune, a thin layer of coarse-grained yellow eroded sand covered the excavation area. Apparently, the dune crest had been eroded

48 In the original publications the term 'working floor' is used.

49 The newly discovered mace-head fragment fitting this burnt fragment is discussed in chapter 4.

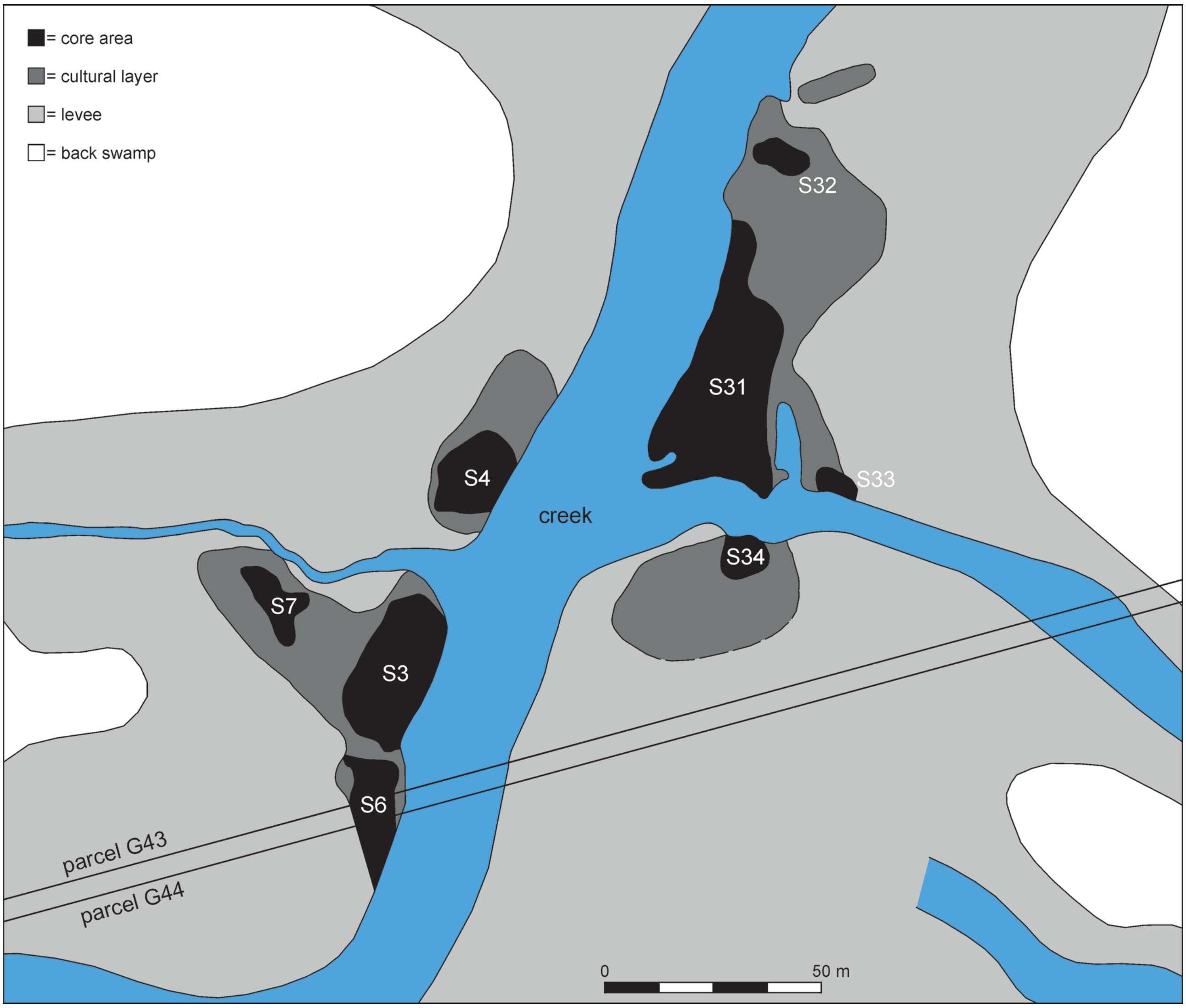

Figure 2.9 Core areas and peripheral areas at parcel G43 (also see table 2.1). Adapted from Fokkens 1978, fig. 16.

resulting in the disappearance of the A horizon and large parts of the B horizon.

Archaeological features and finds
Most of the 39 features were hearths, characterised as black or dark grey, sandy concentrations, holding charcoal. Five features contained no or only small amounts of charcoal and were interpreted as pits. All features were shallow which is (partly) the result of the erosion (Price 1981: 85-88).

According to Price (1981: 91-96) the team excavated 2895 flint artefacts from the erosion layer and 2369 flints from the dune sand[50], along with 39 pieces of rock, 6 fragments of bone, and 41 potsherds. As the middle 14 m of the trench was located at the truncated dune top, an amount of archaeological material must have been washed away, leaving large parts of the artefacts in secondary position and only a small part *in situ*. Only on the slopes did the amount of artefacts *in situ* exceed the amount of eroded material. The vertical distribution suggested at least two stages in the deposition of the artefacts. Price (ibid: 99-100) consequently suggested an aceramic Mesolithic occupation before 4800 BC, and a ceramic occupation starting around 4300 BC. In the article, Price (ibid: 101-102) defines this period as *Ceramic Mesolithic*.

The human remains were limited to grave XII, a fragmentary burial in a poorly defined grave without associated grave goods (Meiklejohn & Constandse-Westermann 1978: 59).

2.7.10 Trench S24 (parcel H46)
After the completion of the excavation of trench S23 in 1976, the team of the University of Wisconsin (Madison)

50 The number of flint artefacts from the text of the article (Price 1981) is not in agreement with the number of artefacts in the published tables. Furthermore, the artefacts studied for this research, recovered from the find boxes, is in turn not in agreement with any of the numbers published by Price (see chapter 5 section 5.1.6).

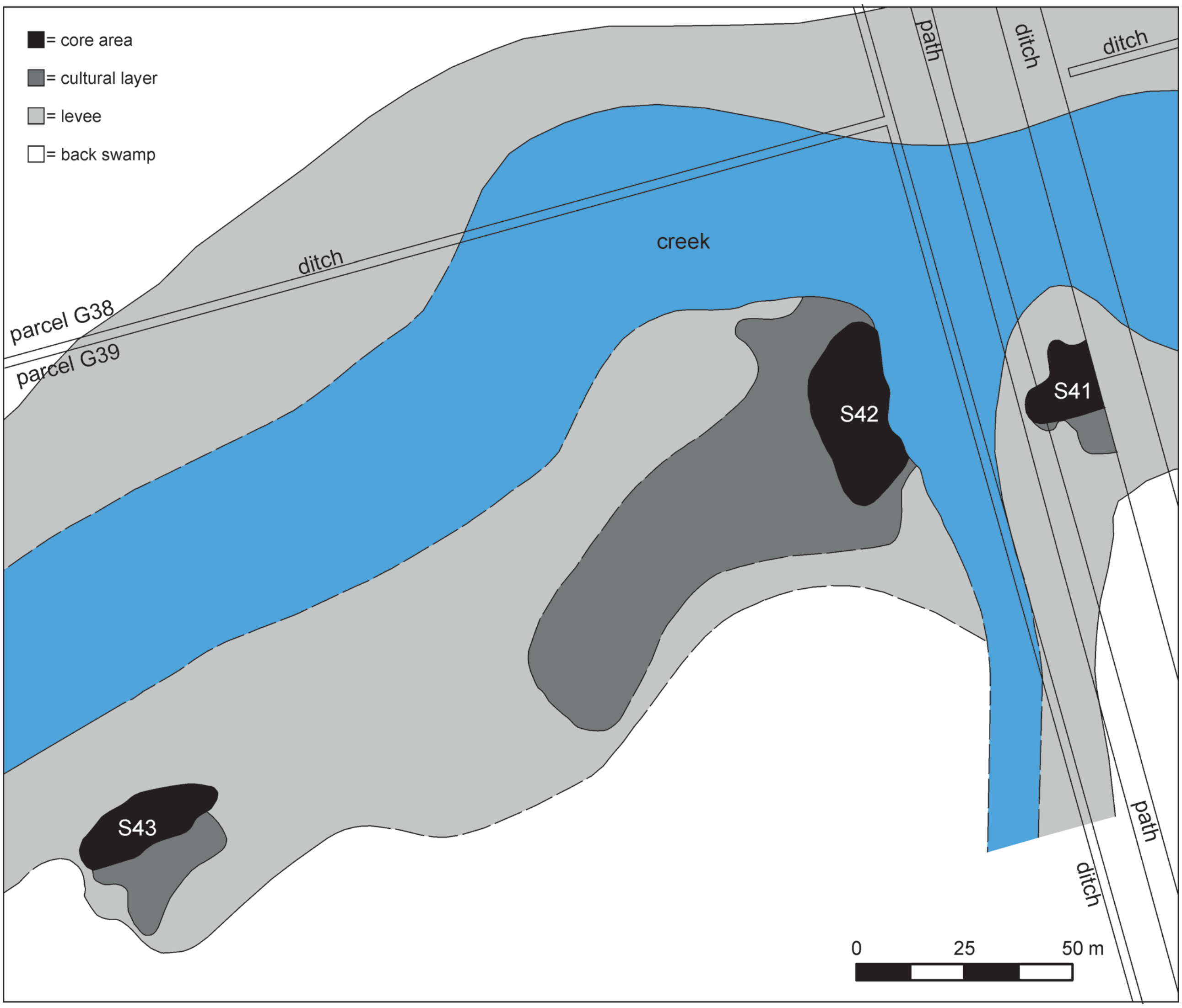

Figure 2.10 Core areas and peripheral areas at parcel G39 (also see table 2.1). Adapted from Fokkens 1978, fig. 11.

dug a small test trench of 2x4 m, located fifteen metres to the north of trench S23 (see figure 2.8). A different excavation technique was used on this site. After removing the clay and most of the peat deposits, the lower peat and the dune sand were brought up in blocks by machine. The sediment was spread out on the surface of the field and was checked by hand for any archaeological remains. Price (1981: 94) recovered no organic remains, only flint artefacts.

2.7.11 Trench S25 (parcel H46)

This newly discovered area revealed itself during the 2008 coring campaign. Between the river dune and the creek located to the north an area of matured clay forms a dry bank approximately 10 m wide. The archaeological value of this levee is established by the numerous pieces of charcoal found in the core samples (Geuverink et al. 2009, Raemaekers & Geuverink 2009). Therefore, a small trial excavation was conducted in 2009. The excavation consisted of three 5x5 m trenches of which the research in trenches 1 and 2 was restricted to 1x1 m test pits due to the absence of any finds. Trench 3, bordering the river dune, was researched more extensively (3x5 m) and yielded a large amount of charcoal in combination with flint and pottery. On the basis of the depth of the finds and a first inventory of their characteristics the occupation at trench S25 dates just after 4000 cal BC. In 2010 a more extensive excavation was undertaken in trenches 4, 5 and 6 (Raemaekers et al. 2011a).

2.7.12 Sites S31/S32/S33 and site S34 (parcel G43)

These sites were discovered during the coring campaign of 1972-1973 by L. Hacquebord and were re-examined by H. Fokkens in 1977 (figure 2.9). Beside these two campaigns no further research was conducted at these sites (Hacquebord 1976, Fokkens 1978). The three dark coloured core regions forming site S31, site S32, and site S33 (areas D, E and Q) are located in a 20 cm thick peripheral area of c. 2700 m². Site S31 is the largest of all Swifterbant sites and extends over an area of roughly 1200 m². The cultural layer has varying depths of 20 or 30 cm up to 50 cm. The c. 125 m² core of site S32 has a depth of 30 cm while the small site S33 measures c. 50 m² with a maximum depth of 20 cm. Site S34 has a separate position south of the creek (area C). It comprises a peripheral area of c. 1100 m² with a core region of 100 m². The depth of the peripheral layer is c. 20 cm while the core region only measures 10 to 15 cm (Fokkens 1978: 15-17). As none of these sites is exposed in the ditch slopes, the research remained limited to the coring campaigns.

2.7.13 Site S41 (parcel G39/G44)

This site was presumably discovered in 1965 during the ditch slope inspections (Van der Heide 1966a). It was located in detail by H. Fokkens during his coring campaign in 1977 (figure 2.10). The cultural layer, with an average depth of 20 cm, is made up of a peripheral area of c. 375 m² with a dark core area of 275 m². At that time, only part of the cultural layer could be explored. It is not known whether the cultural layer continues on the other side of the ditch on parcel G44 because growing crops hindered the coring campaign (Fokkens 1978: 10). Thus the only research conducted at this site was the coring campaign and the stratigraphical description of the ditch slope section in 1978. During the investigation of the ditch several potsherds and stone artefacts were found (Hacquebord 1976, Fokkens 1978).

2.7.14 Sites S42/S43 (parcel G39)

These two sites were found during the coring campaign of 1972-1973 (figure 2.10). They were re-examined by H. Fokkens during his coring campaign in 1977 but were never excavated (Hacquebord 1976, Fokkens 1978). Site S42 is made up of a large peripheral area of c. 3500 m² with a core area of 800 m². The average thickness of the peripheral layer is 10 cm whereas that of the core is 25 cm. The core area of site S43 lies north of the c. 600 m² large periphery and measures c. 350 m². The layer is 25 to 30 cm thick with several peaks up to 40 cm (Fokkens 1978: 11-12).

2.7.15 Site S51 (parcels G15/G16)

Research area and geology

This levee site was first mentioned by H. Fokkens (1978) when he described four occupation areas. I will uphold this division but will not number them separately. Because the large creek running through this area has eroded parts of the occupation layer it is unclear how many sites there may originally have been on this levee. Of cultural layer N a part of c. 100 m² of peripheral area with a core region of 25 m² remains. On complex M the peripheral region covers an area of c. 225 m². Within this area three core regions are coloured black. Together they cover an area of c. 150 m². As they all have the same characteristics they are considered as one complex. The cultural layers O and P are so heavily eroded that their core area no longer remains if they had a core region in the first place. The peripheral regions are c. 75 m² and c. 200 m² respectively.

There was one small excavation in 1978. The few articles which were published on this site are generalised and never give any information on the field work which was conducted; therefore I had to rely on the field notes. No information on the precise position of the trench in relation to the location of the site could be retrieved either. Therefore, an explorative coring session was conducted in 2010 to locate the excavation trench. It was concluded that the excavation covered the two westernmost core regions of complex M located on parcel G16 (pers. comm. D. Velthuizen 2010).

The excavation consisted of two trench segments with an east-west orientation (figure 2.11 and table 2.3). The first segment, located furthest to the west, measured 5x15 m; the second segment, located only 1 m to the east, was smaller measuring 5x9 m. Two north-south extensions were dug at the western end of segment 2 to gain a better insight in the stratigraphy. Both extensions had different dimensions; the one leading to the north measured 7x1.3 m, the one to the south 3x1.5 m. In the field notes it is mentioned that segment 1 was excavated in layers of 5 cm. I can only presume that segment 2 and the extensions were excavated in the same way. Because not all the soil, collected per square metre, could be sieved due to the breakdown of technical equipment, the quantity was reduced to 3 litre probes, which is 2% of the normally sieved quantity (Deckers 1979: 165, 171).

The cultural layer was thickest at the west side of trench segment 1 where it was excavated in 4 layers (A-D). The field notes are not clear about the number of layers dug in trench segment 2 or any of the extensions. Relying on the finds numbers and coordinates there were presumably only three (A-C). Deckers stated that at the end of the northern extension the cultural layer had changed into back swamp deposits. He also claimed that the western border of the cultural layer ran across trench segment 1. These observations and the fact that in segment 1 clay was found underneath layer B, made Deckers conclude that the major part of the site had been washed away by the creek and that only a strip of one to two metres of the cultural layer had been left *in situ* (Deckers 1979: 165).

Archaeological features and finds

Two features were found, a hearth and an unspecified feature. In the latter several finds were recovered such as a bone axe, a wooden shaft, two stones and two pieces of flint. The flint material recovered at the site consisted of 225 pieces, of which 79 were hand collected and 146 were obtained by sieving. The vertical flint distribution seems quite homogeneous throughout the cultural layer; only

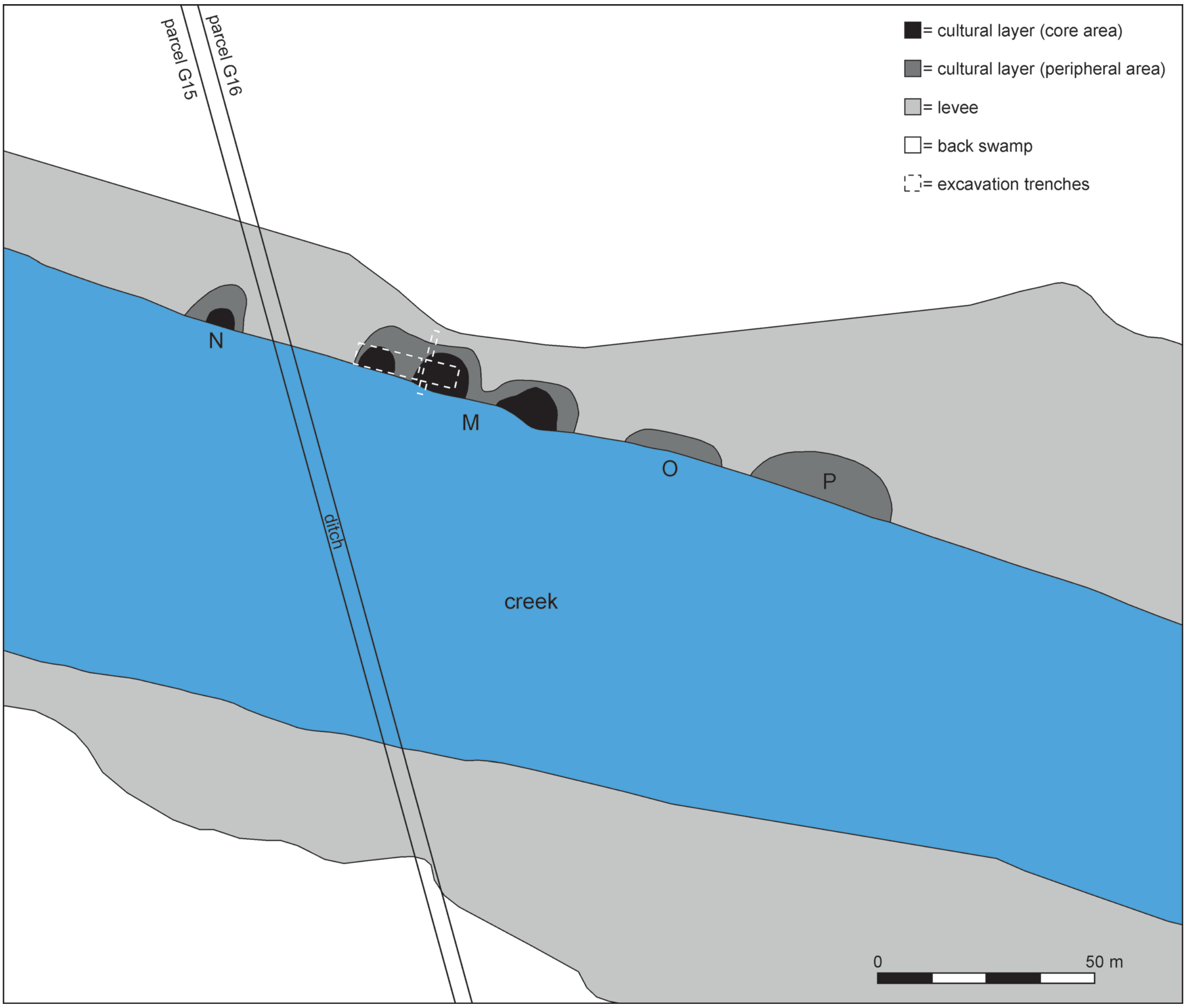

Figure 2.11 The excavation trench at site S51 (also see table 2.1). Adapted from Fokkens 1978, fig. 27.

horizontally, Deckers (1979: 170) could distinguish two flint concentrations. Bienenfeld (1985) mentions 223 pieces of flint which were all examined for the presence of use-wear traces. The number of potsherds varies per publication. Deckers (1979: 147) mentions 1278 potsherds, whereas de Roever (2004: 60) is vaguer and mentions c. 1270 potsherds.

2.7.16 Site S61 (parcel G76)

Research area and geology

This dune site was discovered in 1978 during ditch slope inspections. According to Deckers (1979: 145) there has been a partial excavation of the site. The only detailed information can be found in de Roever (2004: 28), who stated that a trench of c. 3x14 m was excavated by the BAI in 1978. The northern half of the trench was broadened by 2m. The excavation drawings confirm this depicting a quite large trench with maximum dimensions of 5x15 m whereas to the south the trench becomes narrower to only 3 m.

De Roever (ibid: 28) describes the different soil layers that were excavated per layer as much as possible. She differentiates a clay layer (L) and a clayey-peaty layer (K) flanking the dune body as two refuse layers when living conditions became increasingly wet, and three different layers (A-C) in the sandy river dune. The latter are a sandy vegetation layer (A), the dark sandy A-1 horizon (B), and the sandy eluviation layer A-2 horizon (C), currently defined as E horizons. In the southern half of the trench the dune forms its highest point at -4.70 m NAP, whereas in the northern half the dune's surface lowers to -6.10 m NAP.

Archaeological finds

The only detailed information can be found in de Roever (2004: 28-29). The archaeological remains mainly comprise pottery and flint artefacts. According to de Roever, the number of stone and bone fragments is negligible. The higher parts of the dune revealed little material, 25 potsherds and 26 flint artefacts mainly from the A-1 horizon. The majority of the pottery, c. 180 potsherds, was recovered from the slope of the dune in the northern half of the trench and mainly from the clayey layers and the two upper sand layers. The flint material is mainly dispersed deeper. No flint artefacts were discovered in the clay layers while little was recovered from the upper two sandy layers (c. 195 artefacts), while the bulk of the material, c. 465 artefacts, was retrieved from the lowest level, the A-2 horizon[51]. This makes de Roever (2004: 29) and Deckers et al. (1980: 142) conclude that the layer with the pottery is situated clearly above the Mesolithic layer.

2.7.17 Site S71 (parcel H129)

This northernmost river dune has seen little investigation. It was discovered during the large-scale prospecting in 1977. The dune has a length of c. 350 m and comprises three small peaks. The archaeological relevance was attested when a ditch section near the *Kamperhoekweg*, running through the dune, revealed a charcoal concentration. The coring campaign of 2000 by RAAP Archaeological Consultancy was located at the middle of the three heights of the river dune. The dune appeared to be narrow, some 30 m, with a maximum height of -5.20 m NAP. Evidence of prehistoric occupation was found in 14 of the 81 corings, all located at or near the highest parts of the dune. The finds comprise thirteen charcoal samples and two small flint chips (Raemaekers 2000, pers. comm. Raemaekers 2009).

2.7.18 Sites S80-S84 (parcels G20 and H1-H4)

A complicated research history

In 1959, the first traces of human occupation in the Swifterbant area were revealed on these parcels. The archaeological remains were first mentioned by Van der Heide (1959) as he spoke of flint artefacts on a river dune, found during the digging of ditch II-N-14. As a result of these finds, a few test trenches were excavated revealing more flint material and Bell Beaker potsherds. All these artefacts were retrieved from an eroded sand layer. Van der Heide also mentioned that the actual top of the dune was strongly eroded. The only currently remaining material from 1959 are some flint artefacts from H4; the present location of the pottery is unknown[52]. Hence, it is believed that Van der Heide is speaking of parcel H4. In a following publication Van der Heide (1966a: 203) mentioned *vindplaats 7* or site 7, in the north-western area of section H. He described the site as "a high river dune with eroded top and preserved podsol on its slopes. On these slopes, some flint artefacts with retouch were retrieved …" (1966a: 208, my translation). Remarkably the pottery is no longer mentioned. Taking the material from H4 collected in 1959 into account, it is most likely Van der Heide is still referring to H4 as there is no evidence of another site being found in that north-western area between 1959 and 1966. The question remains whether he was indeed referring to H4 since Van der Waals & Waterbolk (1976: 4) place "the first traces of human occupation … in the ditch intersecting a riverbank dune in lot H3". In the drawing in Meiklejohn & Constandse-Westermann (1978: fig. 1) site S81 indeed ended up on parcel H3. In addition, Deckers et al. (1980: 142) announced a pilot study of an intact part of the river dune site S81 on parcel H3. The 'disappearance' of the pottery in the article of Van der Heide (1966a) may suggest a new site altogether or the loss of the pottery.

Several issues can be deduced from these three, somewhat vague, references. First, the 1959 excavation revealed most likely Bell Beaker pottery and flint material from an eroded sand layer. If we assume that this pottery is indeed Bell Beaker pottery, these finds could be very similar to those from site S2 where Bell Beaker pottery and an oval axe were found in an eroded sand layer deposited above the cultural layer designated to the Swifterbant culture. However, the material from parcel H4 also includes a microlith which may have come from a different layer or may have been intermixed with older material. Second, the material was most likely excavated on parcel H4 as there is no reason to believe that Van der Heide would have been mistaken about the location of the test trenches. It is more likely that the confusion started with Van der Waals & Waterbolk (1976). Their information, provided by a secondary source in the person of P.J. Ente, mentioned the ditch alongside H3 as the location of the first traces of human occupation. Technically, that is the same ditch Van der Heide was speaking about but the wrong, i.e. opposite side. It is a fact that the river dune covers both sides of the ditch and that the cultural layer is most likely present on both parcels, thus on H3 and on H4. Third, it is unclear why Meiklejohn & Constandse-Westermann (1978) depicted site S81 on parcel H3. If this is the wrong interpretation of "the ditch alongside H3" than site S81 should be located on H4. An alternative presented here, as there is no way of currently resolving this case, would be to designate the site on H4 as site S80 and to reserve the name "site S81" for the site possibly present on H3. As the river dune reveals sites in at least five locations (see below), there is a high possibility that there will be a site on parcel H3 as well.

In 1993, flint artefacts and pottery were retrieved from the north-eastern ditch at parcel H2. Later that year, another ditch slope inspection was performed at the site revealing

51 These numbers do not correspond with the analysis conducted here; the conclusions are also slightly changed.

52 In the course of this investigation, the attempt was made to retrieve these Bell Beaker potsherds. However, this was without success. Even the detailed MA thesis of Hogestijn (1986) discussing the prehistoric remains in Flevoland did not address these finds.

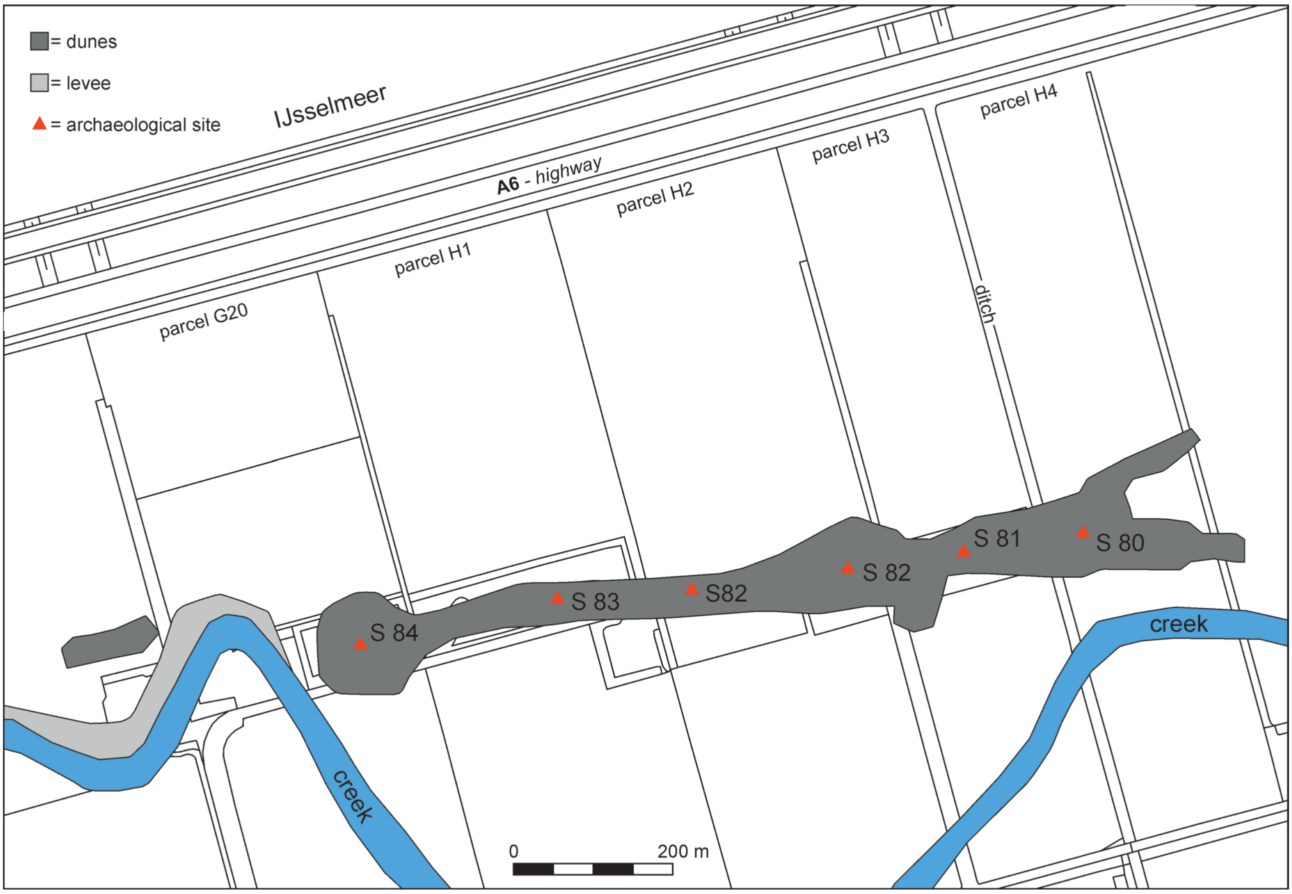

Figure 2.12 The different sites at parcels G20 and H1-H4. Adapted from Dresscher & Raemaekers 2001, fig. 3.

more flint and pottery, along with stone artefacts, large pieces of wood, and charcoal (Jordanov 2005: 4, 11). The pottery was defined as Swifterbant pottery and several radiocarbon dates were also obtained (see section 2.8). The other material comprises 10 pieces of flint (presumably 3 scrapers and 7 flakes), 4 pieces of stone, and 15 potsherds. A planned test trench could not be excavated due to intruding groundwater.

The ditch slope inspections revealed that the highest tip of the river dune was located just below the current surface whereas the dune body continues below the lowest point of the ditch.

At parcel H2 two test trenches were supposedly dug in 2002 (Jordanov 2005) by the province of Flevoland (Dutch State Service for Archaeological Heritage Management) in cooperation with local amateurs. Although the excavation permit was requested for parcel H2, in the report the two trenches were depicted on parcel H1. Yet, in the report parcel H2 is mentioned as the location of the trenches. Verification of the drawings from Jordanov revealed that it is indeed parcel H1 where the test trenches were located. The test trenches were 2x2 m in size and excavated in squares of 50x50 cm in layers of 5 cm. Large finds were registered individually; the soil was then sieved over a sieve with 2 mm meshes to collect small artefacts. According the publication, finds include 125 flint artefacts (ibid: 41) and charcoal; there were also five hearth pits with a documented depth of 0.34-0.40 m (ibid: 54, 58). The presence of B-points indicates that (part of) the occupation took place during the Mesolithic (ibid: 44). The three available radiocarbon dates on charcoal samples also underline the Mesolithic presence at the site.

As part of the 2002 research, up to 140 cores were carried out along c. 675 m of the central part of the river dune (ibid: 25) over a width of c. 100 m, thus spanning sites S82-S84. The main objective of this campaign was to chart the local geology and to determine whether the dune surface was intact. It was concluded that the higher parts of the dune were eroded. The cores confirmed the location of the known sites by the presence of archaeological indicators, and also provided additional information on the size of these various sites. On parcel G20 the position of site S84 was confirmed; its measurements are c. 135x45 m. The location of site S83 on parcel H1 was also verified, the site is approximately 90x30 m. On parcel H2, two separate clusters of archaeological indicators were observed. The first cluster extends over a length of c. 70 m and is approximately 70 m away from the second cluster measuring c. 30 m in length. The width of these two clusters was not recorded. In the past, this site has been designated S82.

This name will be maintained despite the fact that two separate sites may, or may not, be present on the parcel.

If all these observations are combined, it gives the impression that this river dune is one large site or at least a sequential chain of four, five or possibly even six core areas providing little more information than being designated as sites S81-S84 in the past.

The different sites
The c. 1.5 km long river dune on which sites S80-S84 are located is a geomorphological unit from which at least five find locations are known. The turbulent research history complicates the identification, distinction, and designation of the different sites. Furthermore, the current research does not enable me to pronounce upon the nature of the archaeological finds. Are these a sequential chain of separate find locations or do these form one large blanket of continuous finds?

For convenience, the designations used in this research will use one marker per parcel (figure 2.12), regardless of the number of find spots, trenches, or corings. The easternmost site, located on parcel H4, is site S80, documented in 1959 by Van der Heide (1959). This designation is with the presumption that the material from 1959 is located on H4. Site S81 is reserved for the second easternmost site, located on parcel H3, the possibly referred site (see above) by Van der Heide (1966a) and consequently Van der Waals & Waterbolk (1976) and Deckers et al. (1980). The archaeological finds on parcel H2 are designated as site S82. This relates to a scatter of Swifterbant potsherds and a few flint artefacts, including one scraper, recovered from the ditch running parallel to the *Klingenweg*, but also to the two clusters of corings with archaeological indicators. Site S83, located on parcel H1, is the fourth site characterised by a set of positive corings and the two small test trenches from 2002. The westernmost find spot site S84, located on G20, consists of an unidentified number of flint artefacts.

2.8 The different occupation phases

2.8.1 Discussion of the radiocarbon dates

Over the years a wide collection of radiocarbon dates have been gathered at the Swifterbant sites. In the 1960's and 1970's dates were mainly obtained from samples of charcoal from hearths or the occupation layer and of bone collagen from skeletal remains. Two additional dates were obtained from the base of the peat overlying the consolidated clay. Of all these dates, conducted with the conventional dating method, several are now considered to be unreliable (Lanting & Van der Plicht 1996, 2000, 2002). The reasons for discard are insufficient sample treatment, the presence of reservoir-effect, and a carbon content that is too low. Most of the dates obtained in the 1960's and 1970's have already been published[53], often in more than one publication. One of the most conveniently arranged overviews is published by de Roever (2004: 14).

Together with the New Swifterbant Project, new dating initiatives have been undertaken. It concerns a sequence of cereal grains out of the cultural layer at site S3 which have been dated as part of an Oxford-based research project (table 2.4), several dated samples from the newly excavated site S4 (Raemaekers et al. in prep.), one charcoal fragment from a feature at trench S22 (Drenth & Niekus 2008: 50, Drenth & Niekus 2010: 754) and a dating program on the human burials from the river dune sites (Geuverink et al. 2009: 8-9).

2.8.2 The different occupation phases

The river dune sites
The old radiocarbon dates suggested different occupation events spread over the different river dunes of which some occurred isolated and some would overlap. However, new radiocarbon dates seem to fill some of the gaps in between these occupation phases (table 2.4). Therefore, it would appear that the combination of the old and new radiocarbon dates suggest 'occupation continuity' on the archaeological time scale (Peeters 2009: 698), some sort of 'on-again, off-again' occupation of the river dunes at Swifterbant. Only a few of these occupation phases are known to us, as limited radiocarbon samples have been taken. One may presume that more dating samples might result in some sort of uninterrupted chain suggesting long-term use of the river dunes. The current dates suggest Mesolithic as well as the Early and Middle Swifterbant phases between c. 6700 and 4000/3700 cal BC (Geuverink et al. 2009, Raemaekers et al. 2011a).

The levee sites
A similar 'continuous occupation' applies for the levee sites, but on a smaller time-scale. The combined evidence of the different levee sites point to an occupation phase between c. 4300 and 4000 cal BC. It appears that this phase may be described as the main occupation phase, an era in which the cultural layers were deposited and the bulk of the archaeological remains were left behind. Although this phase most likely represents 'occupation continuity' it may also be characterised by 'behavioural discontinuity' (Peeters 2009: 698). All the different levees were used side by side, yet in different intensities, for varying activities, and in interchangeable combinations for, at the most, a few hundred years. However, soil micromorphology suggests that some time before and after this main occupation phase cultivation of the localities must have taken

53 Five dates have been published containing misprints. These are GrN-5606 in Deckers 1979: 147, GrN-7364 in Deckers 1979: 147, GrN-7505 in Casparie et al. 1977: 30, GrN-7043 in de Roever-Bonnet et al. 1979: 12, GrN-6709 in Price 1981: 95.

place as well (Huisman et al. 2009). Thus, the exploitation phase of the area, during which cultivation may have been combined with for example hunting or fishing, must have been longer than the main occupation phase.

Table 2.4 Available radiocarbon dates for the sites of the Swifterbant cluster

Site	Dated material	Laboratory nr	BP	2σ range*	δ 13C (‰)	Cv (%)	Publication
Site S2	Charcoal from occupation layer	GrN-5443	5300 ± 40	4252 - 3995			Lanting & Van der Plicht 1999/2000 ***
Site S3	Charred wood from stick from hearth in upper half occupation layer	GrN-7043 (a)	5375 ± 40	4334 - 4056			Lanting & Van der Plicht 1999/2000 ***
Site S3	Charcoal from contact zone (upper occupation level / covering clay)	GrN-7364 (b)	5340 ± 55	4329 - 4042			Lanting & Van der Plicht 1999/2000 ***
Site S3	Charred wood from post from one of the later basal layers	GrN-7044	5310 ± 50	4318 - 3994			Lanting & Van der Plicht 1999/2000 ***
Site S3	Collected charcoal (sticks and twigs) of lowermost occupation level	GrN-7042	5295 ± 40	4241 - 3993			de Roever 2004 ***
Site S3	Charcoal from upper cultural layer	GrN-6896	5230 ± 40	4229 - 3963			Lanting & Van der Plicht 1999/2000 ***
Site S3	Charred food remains from pottery	UtC-1046	5490 ± 70	4493 - 4081	-26.10	55	Lanting & Van der Plicht 1999/2000
Trench S5	Wood	GrN-8815	5340 ± 35	4317 - 4050			Lanting & Van der Plicht 1999/2000
Trench S5	Wood	GrN-8816	5340 ± 35	4317 - 4050			Lanting & Van der Plicht 1999/2000
Trench S5	Wood	GrN-8814	5320 ± 45	4319 - 4003			Lanting & Van der Plicht 1999/2000
Site S3	Wood	GrN-8810	5265 ± 35	4231 - 3985			Lanting & Van der Plicht 1999/2000
Site S3	Wood	GrN-8811	5255 ± 40	4230 - 3976			Lanting & Van der Plicht 1999/2000
Trench S5	Wood	GrN-8812	5255 ± 35	4230 - 3978			Lanting & Van der Plicht 1999/2000
Trench S5	Wood	GrN-8817	5205 ± 40	4226 - 3951			Lanting & Van der Plicht 1999/2000
Site S3	Charred Hordeum	OxA-15611	5358 ± 34	4327 - 4053	-24.8		https://c14.arch.ox.ac.uk/database/db.php
Site S3	Charred Hordeum	OxA-15609	5334 ± 35	4315 - 4048	-24.2		https://c14.arch.ox.ac.uk/database/db.php
Site S3	Charred Hordeum	OxA-15610	5278 ± 36	4233 - 3992	-25.1		https://c14.arch.ox.ac.uk/database/db.php
Site S3	Charred Hordeum	OxA-15612	5269 ± 37	4231 - 3986	-24.7		https://c14.arch.ox.ac.uk/database/db.php
Site S3	Charred Hordeum	OxA-15608	5267 ± 35	4231 - 3986	-25.3		https://c14.arch.ox.ac.uk/database/db.php
Site S4	Beaver bone 3387 (collagen)	GrA-35308	5290 ± 40	4239 - 3992			Unpublished
Site S4	Beaver bone 3387 (carbonate)	GrA-34814	5245 ± 40	4229 - 3971			Unpublished
Site S4	Seed	GrN-30447	5390 ± 70	4351 - 4046			Unpublished
Site S4	Seed	GrA-33954	5350 ± 45	4326 - 4049			Unpublished
Site S4	Seed	GrA-33953	5010 ± 40	3944 - 3704			Unpublished
S11	Charcoal (feature 8)	GrN-10351	7260 ± 110	6388 - 5921			Lanting & Van der Plicht 1997/1998
S11	Charcoal (feature 6)	GrN-7215	6330 ± 45	5465 - 5216			Lanting & Van der Plicht 1997/1998 ***
S11	Charcoal (feature 4)	GrN-7214	6285 ± 45	5367 - 5079			Lanting & Van der Plicht 1997/1998 ***
S11	Charred food remains from pottery	GrA-5402	5400 ± 70	4358 - 4047	-27.2	51.8	Lanting & Van der Plicht 1999/2000

Table 2.4 *continued*

Site	Dated material	Laboratory nr	BP	2σ range*	δ 13C (‰)	Cv (%)	Publication
S11	Vegetable temper	UTC-7089-3	6380 ± 70	5478 - 5223			Hogestijn & Peeters 1996
S11	Vegetable temper	UTC-7089-2	6310 ± 110	5481 - 5006			Hogestijn & Peeters 1996
S11	Vegetable temper	UTC-7060-2	6210 ± 80	5341 - 4947			Hogestijn & Peeters 1996
S11	Vegetable temper	UTC-6864-2	6180 ± 160	5474 - 4471			Hogestijn & Peeters 1996
S11	Vegetable temper	UTC-6864-3	6150 ± 90	5308 - 4848			Hogestijn & Peeters 1996
S11	Vegetable temper	UTC-7060-1	6030 ± 100	5214 - 4716			Hogestijn & Peeters 1996
S11	Vegetable temper	UTC-7060-3	5990 ± 110	5213 - 4618			Hogestijn & Peeters 1996
S11	Vegetable temper	UTC-6864-4	5900 ± 90	4996 - 4547			Hogestijn & Peeters 1996
S11	Vegetable temper	UTC-3482-2	5670 ± 90	4707 - 4350			Hogestijn & Peeters 1996
S11	Carbonate (bone 42) (feature 42)	GrA-39707	5256 ± 35	4230 - 3979			Unpublished
S11	Carbonate (skeleton I) (grave I)	GrA-38131	5170 ± 70	4229 - 3795			Unpublished
Trench S21	Charcoal from hearth	GrN-6709 (c)	7775 ± 40	6680 - 6501			Lanting & Van der Plicht 1997/1998 ***
Trench S22	Charcoal from hearth	GrN-6710	6875 ± 35	5843 - 5674			Lanting & Van der Plicht 1997/1998 ***
Trench S21	Charcoal from hearth	GrN-6708	6670 ± 35	5657 - 5527			Lanting & Van der Plicht 1997/1998 ***
Trench S22	Charcoal (feature 4: Geröllkeule)	GrN-30973	6280 ± 40	5360 - 5080			Drenth & Niekus 2008, 2010
Trench S23	Charcoal from hearth (feature 27)	GrN-8248	6240 ± 50	5316 - 5056			Lanting & Van der Plicht 1997/1998 ***
Trench S22	Carbonate (skeleton VII, grave VII)	GrA-33542 (d)	5650 ± 35	4550 - 4368			Geuverink et al 2009
Trench S21	Carbonate (bone 744, feature 744)	GrA-39709	5640 ± 70	4677 - 4346			Geuverink et al 2009
Trench S22	Carbonate (skeleton II, grave II)	GrA-39712	5500 ± 70	4497 - 4175			Geuverink et al 2009
Trench S21	Carbonate (skeleton XI, grave XI)	GrA-38134	5490 ± 35	4447 - 4261			Geuverink et al 2009
Trench S22	Carbonate (skeleton VIII, grave VIII)	GrA-38135	5480 ± 30	4436 - 4260			Geuverink et al 2009
Trench S21	Carbonate (skeleton IV, grave IV)	GrA-33541 (d)	5425 ± 35	4348 - 4184			Geuverink et al 2009
Trench S21	Carbonate (bone 485, feature 485)	GrA-39708	5400 ± 70	4358 - 4047			Geuverink et al 2009
Trench S22	Carbonate (skeleton VI, grave VI)	GrA-42739	5400 ± 40	4344 - 4071			Geuverink et al 2009
Trench S22	Carbonate (skeleton IX, grave IX)	GrA-38139	5400 ± 30	4339 - 4085			Geuverink et al 2009
Trench S23	Carbonate (skeleton XII, grave XII)	GrA-38140	5370 ± 30	4330 - 4066			Geuverink et al 2009
Trench S21	Carbonate (bone 798, feature 798)	GrA-38138	5305 ± 30	4236 - 4044			Geuverink et al 2009
Trench S22	Carbonate (skeleton I, grave I)	GrA-39711	5295 ± 70	4322 - 3976			Geuverink et al 2009
Trench S21	Carbonate (skeleton III, grave III)	GrA-38133	5200 ± 35	4221 - 3953			Geuverink et al 2009
Site S61	Charcoal, layer C	GrN-10357	6235 ± 50	5313 - 5056			Lanting & Van der Plicht 1997/1998 ***
Site S61	Charcoal, layer K	GrN-10356	5510 ± 70	4501 - 4181			Lanting & Van der Plicht 1999/2000 ***

Table 2.4 continued

Site	Dated material	Laboratory nr	BP	2σ range*	δ 13C (‰)	Cv (%)	Publication
Site S61	Charcoal, layer B	GrN-10355	5300 ± 140	4445 - 3797			Lanting & Van der Plicht 1999/2000 ***
Site S83	Charcoal from hearth pit	UtC 12486	6285 ± 46	5367 - 5078	-24.7		Jordanov 2005
Site S83	Charcoal from hearth pit	UtC 12485	6165 ± 45	5286 - 4988	-25.4		Jordanov 2005
Site S83	Charcoal from residu	UtC 12484**	6271 ± 44	5342 - 5073	-24.8		Jordanov 2005

* Oxcal 4.1, IntCal 04.
** In the text of the original article (Jordanov 2005) this date is refered to as sample UtC12483.
*** Already published between 1976 and 1982.
(a) Misprinted as 5400±40 BP in De Roever-Bonnet et al 1979: 12.
(b) Misprinted as sample from site S2, parcel G42 in Deckers 1979: 147.
(c) Misprinted as 7745±40 BP in Price 1981: 95.
(d) Misprinted as GrN-numbers in Raemaekers et al 2009

Chapter 3

Method and limitations

3.1 Methodology

3.1.1 Introduction

Considering this thesis is my first real familiarisation with the analysis of stone artefacts, i.e. other than flint, it was not self-evident to choose between all the different possible parameters and define them. In this case the most logical choice was to structure the database like that of the existing flint database I have been using for several years, modifying it where necessary according the specific needs for the stone research. Variables have been chosen to correspond as much as possible with those of other researchers. Data have been stored in an MS-Access database.

3.1.2 Method

Stone material

In order to process the large number of stone artefacts an analysis based on three elementary steps or phases was designed. The first and most important phase of the analysis is subdivided into a primary and a secondary classification of the artefacts (figure 3.1). The amount of information a certain stone artefact can provide was the decisive factor in the amount of time spent on that particular artefact. The information content of an artefact is often related to its size or measurements, i.e. a chip may not provide as much information as a core or tool, or even a blade. Also different categories of artefacts, i.e. debitage material or waste material, may provide different sorts of information.

The primary classification of many archaeological artefacts is related either to size or to weight; both may be used as a means of classification. Depending on the specific researcher, a flint artefact measuring 1 to 2 cm or a stone artefact of a certain weight is, after a primary classification, no longer subject to further analysis.

The desired classification based on a 1 cm boundary was not maintained here as a screening test revealed that by doing so the analysis would far exceed the available time limit. Therefore, the boundary of this stone artefact study was set at 3 g. Artefacts lighter than 3 gram (< 3 g) are analysed with a limited set of variables. Artefacts weighing 3 gram or more (≥ 3 g) are analysed with an extended set of variables.

After this primary classification the artefacts < 3 g were counted and weighed; the other group was studied in detail. For a list of variables, artefact types, and definitions see appendix 1. The larger objects are then subject to a secondary classification. This is the division by typology into five main categories: tools, ornaments, debitage material, waste material, and others. The latter are more or less unexpected finds which are therefore not in the typological list and need to be described separately and individually. The differentiation between debitage material and waste material was made to set flakes, blades, and cores aside from indeterminate pieces, pebbles and cobbles, potlids and frost flakes, and possible pieces of debitage or tools.

Both the primary classification, based on weight, and the secondary classification, the typological attribution of the material ≥ 3 g, make up the first phase of the analysis. Some artefacts, such as the tools and ornaments, need to be examined for a second time to check on details and describe them thoroughly so they can be compared to material from other sites in a later stage. This second phase also provides the chance to re-examine other artefact types (cores, flakes …) or verify certain facts or train of thoughts. This is an important phase when errors in measurements, writing or interpretation are noticed and corrected thus limiting the remaining errors in the database.

The third level of the analysis involves the processing of the data. It is only in this third and final stage that the different data sets of each site, i.e. stone and flint, are compared to the data sets of the other sites at Swifterbant. Finally, the results of the analyses of the sites in the Swifterbant area are compared to those of the other Swifterbant sites.

Flint material

As with the stone artefacts, the flint artefacts were examined according to three elementary steps or phases. The first phase is divided into a primary and a secondary classification of the artefacts (figure 3.2), the second phase has only one focus point and the third phase is again bipartite. The most important aspect in the first phase is size. In most, if not all, typological or technological flint analyses a division is made according to size since the amount of information an artefact can provide is often related to its measurements. Therefore the extensiveness of the analysis

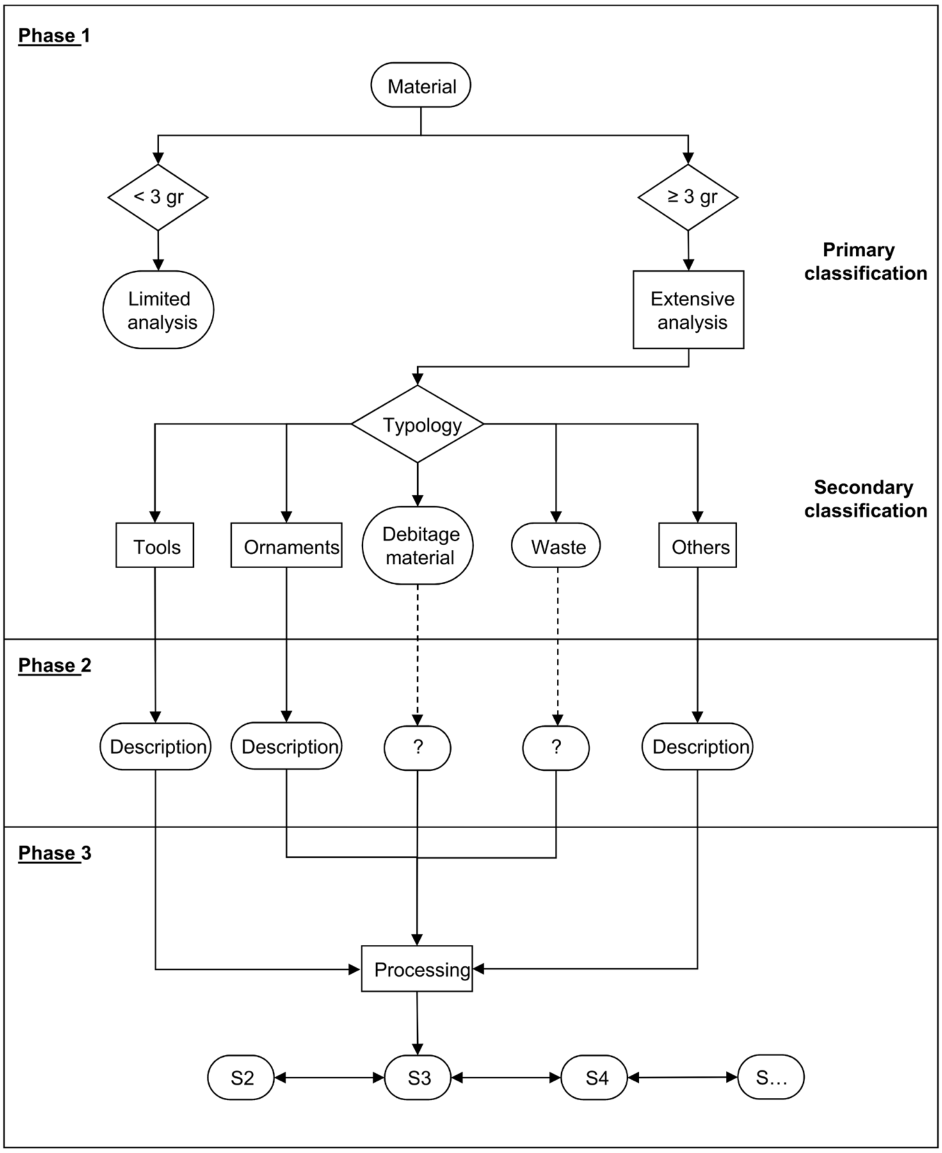

Figure 3.1 Flow chart of the stone analysis.

and the amount of time spent on a particular artefact is related to its size.

The primary classification of the first phase is based on the length of the artefacts measured along the debitage axis. The limit is set on 1 cm. In general an artefact measuring less than 1 cm (< 1 cm) is subject to a limited analysis. Artefacts equal or larger than 1 cm (≥ 1 cm) are analysed with an extended set of variables. The only exception to this rule are artefacts smaller than 1 cm showing clear traces of human alteration, like very small tool fragments. Although these are < 1 cm they will be analysed with the group ≥ 1 cm.

During this primary classification the artefacts < 1 cm are counted, examined for heat exposure and weighed; the artefacts ≥ 1 cm are redirected to the secondary classification for study in detail. For a list of variables, artefact types and definitions see appendix 1. This secondary classification is the division by typology into six main categories: debitage material, tools, bipolar pieces, artefacts with visible use-wear traces, waste material, and others. This last category are more or less unexpected finds which are therefore not in the typological list and need to be described separately and individually. Debitage material and waste material were separated from each other in order to set flakes, blades, rejuvenation pieces, and cores aside from indeterminate pieces, potlids, frost flakes, and nodules. This first phase of the analysis is the first time the material is seen and when it is briefly examined.

Some artefacts, such as tools, need to be examined for a second time to check on details. This happens in the second phase when they are described thoroughly so they can be compared to material from other sites in the third phase. This second phase also provides the opportunity to re-examine other artefact types such as debitage material or to verify certain facts or train of thoughts. Errors

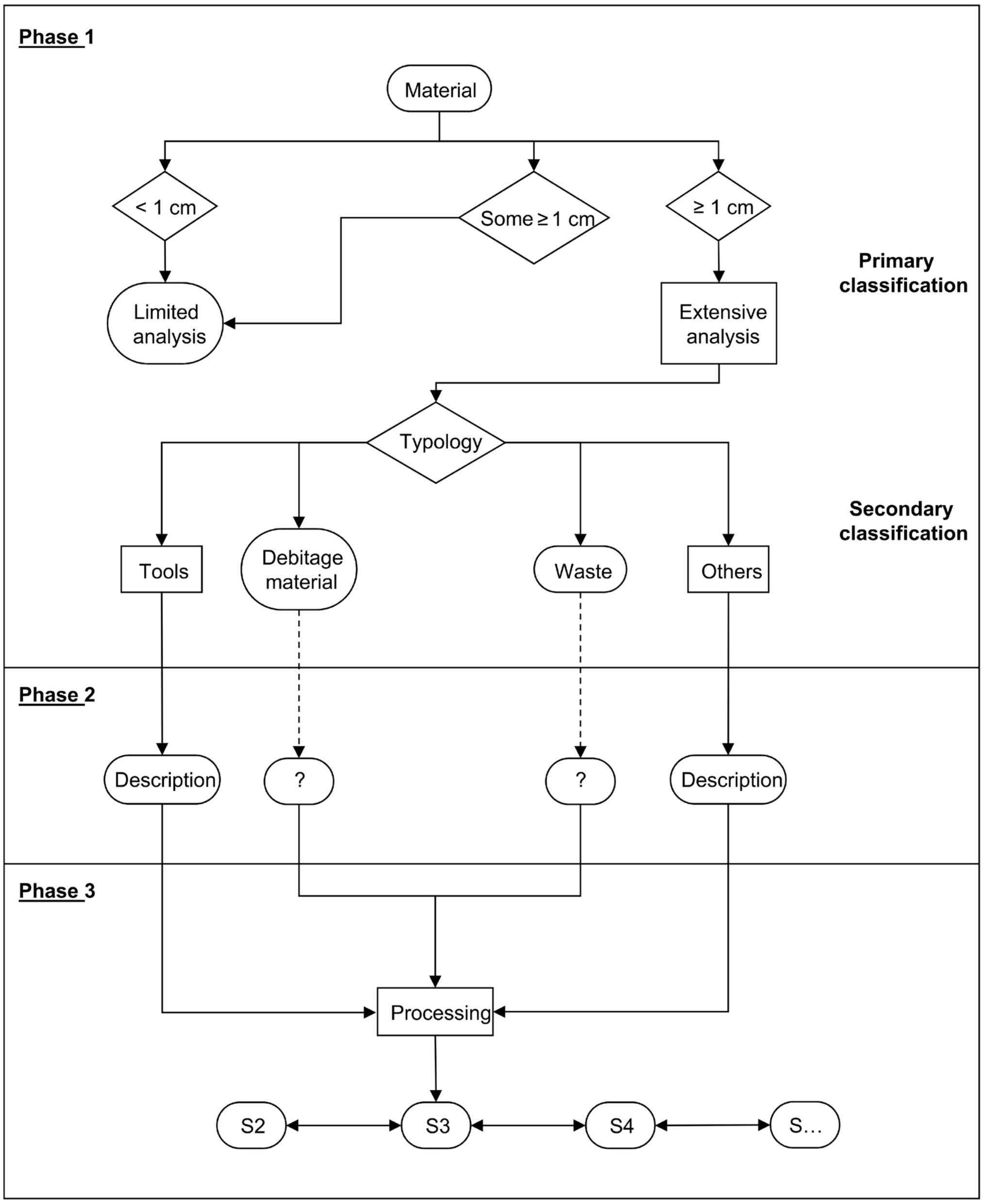

Figure 3.2 Flow chart of the flint analysis.

in measurements or writing can also be noticed and corrected thus limiting the remaining errors in the database. The third and last phase of the analysis engages into the processing of the data. The different data sets of each site are compared to the data sets of the other sites, first within the Swifterbant cluster, later within the bigger entity of the Swifterbant culture.

An essential aspect to this research is the distinction between flakes and blades (see appendix 1 sections 1.1.3 and 1.2.3). The choice was made to define the difference between a flake and a blade purely on a length-width ratio basis. As I am fully aware of the consequences this has on the conclusions of typological composition, technological analysis and even the analysis of operational chains, I maintained this division but added a note during the typological analysis of the artefacts if the blade would be of the regular type, i.e. systematically produced and showing parallel edges and ridges like pressure blades do. As the definition of a blade has two different descriptions, length-width ratio based or techno-morphologically based, the application of this system hopefully allows all researchers to use this data set. Thus, a blade with a length-width ratio of ≥ 2:1, i.e. the length is at least equal to, or larger than, twice its width, may by some researchers be described as a 'blade-like flake' in contrast to a regular, systematically or serially produced blade with parallel edges and ridges or a 'true blade'[1]. In this research all intact or unbroken detachments with a length-width ratio of ≥ 2:1 will be defined as blades, yet blades of the first type will be described as 'less systematically produced blades' or 'irregular blades', while the second type will be referred to as 'regular blades'.

Another aspect to this research is the choice not to make the distinction between blades and bladelets, as this is an arbitrary division based on length. Again, the difference between a blade and a bladelet may differ per researcher, whether a limit of 5 cm or less/more is used, and cannot be applied to fragmented artefacts. The use of the term bladelets, or even blade(lets), would therefore, in my opinion, lead to unnecessary subdividing and possibly even confusion. As a detailed overview of the lengths of the blades is given at all sites, this aspect should not form a problem to the applicability of the data set.

3.1.3 Variables

Stone material

Two different sets of variables were used to analyse the stone artefacts. The artefacts equal to or heavier than 3 g (≥ 3g) are studied according to the following variables: type, form, fragmentation, weathering, stone type, origin, degree of burning, dimensions, weight, refit possibilities, and special characteristics. The stone artefacts lighter than 3 g (< 3g) are analysed using the following variables: number, total weight, and special characteristics. For detailed sub-lists and full definitions of the variables see appendix 1.

Flint material

As with the stone material, the flint material is analysed by two different sets of variables. The flint artefacts equal or larger than 1 cm (≥ 1 cm) are analysed using an extensive dataset. The following variables were recorded: main type, sub type, flint type, degree of burning, percentage of cortex / patina, type of cortex / patina, dimensions, weight, refit possibilities, and special characteristics. The flint artefacts smaller than 1 cm (< 1 cm) are analysed using a limited dataset. These variables include number, degree of burning, total weight, and special characteristics. These small artefacts may be in one piece, i.e. intact chips, or they may be fragments of flakes, blades, rejuvenation pieces or even potlids smaller than 1 cm. Only clear tool fragments are set aside and defined as retouched chips. In this way, even the smallest tool fragments, or renewal chips are analysed in detail. For the full definition of the variables and their subdivision see appendix 1.

3.1.4 Orientation of the artefacts

As in many articles and works the proximal end is placed upward in the explanatory pictures (Crabtree 1972: 44, Beuker 1983: 32, 2010: 68), this is done here the same way. Although in as many other works the proximal end is placed downward (Inizan et al. 1999: 33), it is considered the most logical way of depicting an artefact and holding an artefact during examination as it accords with the way the force is applied during detachment, i.e. debitage axis.

3.2 Research limitations

3.2.1 Fragmentary information

Two aspects contribute to the fragmentary state of this research. First, the loss of information or other forms of data over time, secondly the loss of artefacts over time. The latter is of less impact as it concerns a limited number of artefacts.

As the excavations were conducted between 1961 and 1979 it is no surprise that some information has been lost over time. This fragmentary conservation is due to outdated computer systems, storage in different places, the closing down or fusion of several public authorities, or even the belief that storage of this or that item was unnecessary. All this leads to all sorts of problems. Over time most of the artefacts' coordinates have been lost ruling out any spatial analysis. Because of the loss or absence of spatial information one of the means to assert the homogeneity of an assemblage, i.e. whether it is a single activity event or a cumulative or spatial palimpsest (Bailey 2007), is lost to us. Furthermore, by not knowing which part of a site is excavated, the representativeness of the material may be questioned. Whether a certain artefact was retrieved at the core of the site or on the outskirts may be of great importance for the interpretation of certain activities, both on site and off site.

The second aspect is about the loss of artefacts. In the past, artefacts have been taken out of their finds boxes for research purposes, or to put them on display. Some of these artefacts did not make it back to their designated finds boxes and are currently missing. This is mostly the case with flint tools or other 'highly valued' artefacts as most of the stone artefacts were not analysed in the first place, and little attention was given to them. Additionally, some of the stone and flint artefacts may have been erroneously defined in the past and may therefore still remain undetected in other, non-investigated find boxes. Yet their

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1 Bordes (1961:6) stated « *… [si un] éclat est allongé, de telle manière que sa longueur soit deux fois, ou plus, supérieure à sa largeur, on a affaire à une lame. […] Certaines auteurs, principalement de langue anglaise, distinguent entre lames vraies et éclats laminaires. La lame vraie porterait sur sa face supérieure la trace d'enlèvements antérieurs parallèles et aurait également des bords plus ou moins parallèles.* » Even more, « *Cette distinction, en théorie parfaitement valable, est souvent difficile à faire dans la pratique et nous ne la retiendrons pas.* » For an English translation see Inizan et al. (1999 : 130).

number is presumably very low compared to the vast amount of artefacts studied in this research.

3.2.2 *Heat exposure and thermal alteration*

Heat exposure leads to certain thermal alteration processes such as discolouration, deformation and fragmentation, all of which hamper different aspects of flint analysis. Damage caused by heat exposure reveals itself in a variety of ways. It is a very common phenomenon, yet, controlled experiments on the reaction of flint on heat exposure remains limited. Even more, the different reactions of the different stone types has been studied even less. It is known that flint may first change colour, often to a reddish tinge, then starts to fracture and change colour to different shades of grey. Potlidding may occur at this middle stage. Finally the flint discolours totally to white, i.e. overheating, and fragments (Larsson 2000, Price et al. 1982, Rottländer 1989, Sergant et al. 2006). This process of discolouration hampers, or even prohibits, raw material type analysis whereas fragmentation impedes typological determination and size analysis. For the other stone material, the most distinctive attributes of thermal alteration are also discolouration and fracture patterns (Duncan & Doleman 1991).

3.2.3 *Macroscopic versus microscopic*

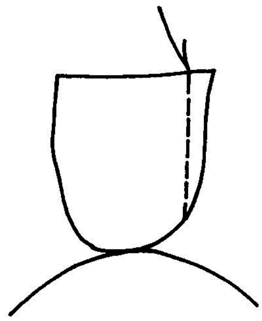
The analyses here were conducted by using only the naked eye and a magnifying glass of x10. Definitions are therefore based on traces and features visible with these two attributes. This may lead to the erroneous definition of blanks or tools. For example, use-wear traces may be present on a blank but remain invisible to the naked eye. Therefore, the definition of that artefact as a simple removal and not as a tool is in fact erroneous. On the other hand, a retouched piece may not be used, yet it will be defined as a tool.

The reliance on a use-wear specialist is therefore rather imperative. Yet, their pronouncements should not be considered the absolute truth as their analyses are indeed an interpretation of the wear traces on an artefact. Experts may use different techniques, resulting in different definitions or may even be in disagreement on certain traces.

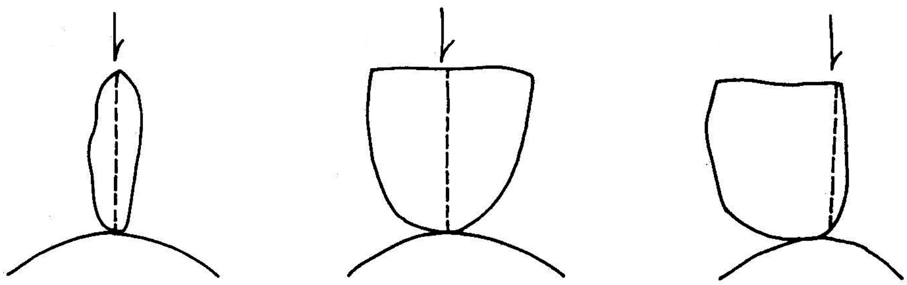
3.2.4 *The complicated nature of bipolar pieces and the bipolar technique*

The technique

The bipolar technique, or hammer-and-anvil technique, can be performed in two ways. Nevertheless, only one of these will result in bipolar flakes with two opposing impact points. With the first technique, also called anvil percussion, the core is placed on the anvil but struck obliquely thus with the force of impact being directed away from the point of contact with the anvil. With the second technique, or bipolar percussion, the core is also placed on the anvil but is struck straight downward from



Schematic representation of anvil percussion.



Schematic representation of bipolar percussion.

Figure 3.3 Schematic representation of anvil percussion and bipolar percussion (taken from Callahan 1987).

above, perpendicular to both the core top and the anvil resulting in a force rebound (figure 3.3) (Callahan 1987: 13). Both will result in ventrally flat flakes with flat bulbs and pronounced ripples (Callahan 1987, Kuijt et al. 1995). Yet, only the second technique will result in crushing and bulbs at one (Kobayashi 1975) or both ends (Callahan 1987). As this research revealed, this definition is too narrow.

It appears that not only flat flakes with sharp ripples are bipolar flakes. As the flake scars on bipolar pieces indicate, curved flakes can also be detached in a bipolar fashion. But how do we set them apart from unidirectional removed flakes? Although many articles have been published on the bipolar subject, little has been written on the characteristics of the bipolar flakes themselves. When bipolar flakes are described, the characteristics are always that of the flat type, they do not include the curved type. These curved flakes presumably largely resemble unidirectionally detached flakes with the addition of a distal impact point or flat bulb. So the bipolar flakes in this study must be regarded as the bare minimum of the existing ones. One might even wonder what happens if the distal impact point is perhaps not always visible.

A single time it was observed that the proximal part of a removal was detached along the fissure coming from that impact point while the 'distal' end showed ripples coming from the opposing end as if it was detached along a latent fissure. Should this artefact be interpreted as being bipolar or as a latent fissure resulting from bi-directional debitage? Does a failed blow during bi-directional debitage leave an impact point or Hertzian cone large enough to be mistaken for bipolar debitage? According to Callahan (1987: 13) a bipolar flake never detaches simultaneously at both ends, although Patterson (1979: 21), Binford (1972: 355), and Crabtree (1972: 10) stated otherwise.

A hundred years of interpretation

Bipolar artefacts have been recognised as a morphological type for over a hundred years (Bardon et al. 1906), but their function has always been a topic of debate. The bipolar pieces are most commonly functionally defined as tools, like wedges (Hayden 1980, Clark & Thompson 1953), chisels, adzes, strike-a-lights (Vaughan 1981), burins (MacDonald 1968), or even as cores (Ballin 1999, Guyodo & Marchand 2005, White 1968). But this debate is not only related to function, other levels of interpretation have been explored to elucidate the use of the bipolar technique. These levels of interpretation focus for example on the production process and the production purpose. In this perspective, the bipolar technique is seen as a means to open round nodules (van Gijn & Niekus 2001), as a way of working poor quality raw materials (Knight 1991), or as the solution to raw material shortage (Callahan 1987, Deckers 1982, Kamminga 1978). More recently another argument was put forward. In this view, the producers' age and identity are focused upon. The technique is seen as evidence of varying degrees of skill of apprentices or children (Stapert 2007, Sternke & Sørensen 2007). It is sometimes even seen as the work of adult women for it is considered a low prestige technique (Flenniken 1979) while in other parts of the world bipolar flakes are used predominantly by men (Kosambi 1967).

This introduction enlightens the complex context in which to define the bipolar pieces and the bipolar technique. It also shows that the artefacts of each site, or even each artefact individually, should be regarded separately because by using the bipolar technique many different artefact types can be made. Therefore, it would be ignorant to think all these artefact types have the same function or definition. Also, it appears that two or more levels of interpretation may apply to one set of bipolar artefacts (Devriendt 2011). However, this is not as simple as it sounds. Despite the fact that some researchers (Hayden 1980, Lothrop 1982) already differentiate between bipolar cores and splintered pieces[2], whether on the typological or functional level, these terms are still often (erroneously) used as synonyms, partly because of poor definitions, partly because of the large variety within the bipolar artefacts, but also because thin bipolar cores may be employed as splintered pieces.

The bipolar pieces at Swifterbant

My personal view on bipolar pieces has changed to some extent during the course of this thesis. As bipolar pieces are most commonly functionally defined, this was my first line of investigation. This turned out to be a somewhat disappointing endeavour (see section 5.5). The denomination of the artefacts needed to be adjusted as well as the interpretation of the possible function of the artefacts (Devriendt 2008a, Devriendt 2011) (see below and section 5.4.3).

During the analysis it was noted that within the vast number of bipolar artefacts three different morphological and technological signatures appeared (figure 3.4). The first group has an overall regular appearance with long flake scars running all the way down from one end to the other. Because of these long removals, they have the appearance of cores. The second group consists of irregular shaped bipolar pieces with both large and small flake scars, some running from one end to the other and some running only half way. The third group is predominantly square in shape, approximately 2 to 3 cm long with most flake scars running only half way. Because of their general appearance and shattered striking ridges, these remind one of splintered pieces. In an earlier article (Devriendt 2008a) the terms 'regular, bipolar cores', 'irregular bipolar pieces' and 'splintered pieces' were used. Because these terms

2 In these articles the term *pièces esquillées* is used.

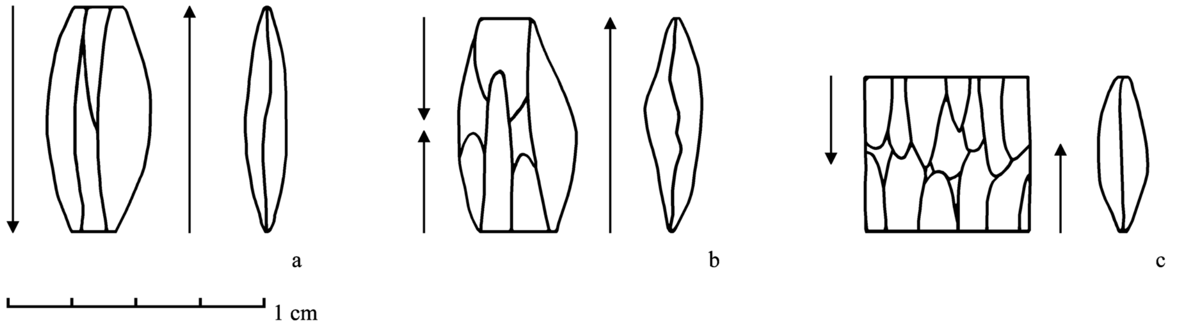


Figure 3.4 Schematic representation of the three different types of bipolar pieces at Swifterbant: a: regular bipolar piece, b: irregular bipolar piece, c: square shaped bipolar piece.

Table 3.1 Terminology of the different types of adzes and axes.

	Adze	Shoe-last axe	Shaft-hole axe
Buttler 1938	Flachhacke / Schuhleistenkeil	-	-
Schwabedissen 1966/1967	Dechsel	Hohe durchlochte Schuhleistenkeil	Durchlochte Breitkeil
Brandt 1967	Schuhleistenkeil	Hohe durchlochte Schuhleistenkeil	Axt
Hoof 1970	-	Seitlich durchbohrte Schuhleistenkeil	Arbeitsaxt
van der Waals 1972	-	Hohe durchlochte Schuhleistenkeil	Durchlochte Breitkeil
Fischer 1982	-	Danubian Shaft-hole Axe	
Bakels 1987	Adze	(flat) Perforated adze	
Schut 1987	Schuhleistenkeil	-	Durchlochte Breitkeil
Klassen & Jonsson 1999	-	Shoe-last axe	Shafthole axe (local production)
Raemaekers 1999	Adze	High perforated adze	Perforated wedge
Spatz 1999	Dechsel	Hohe durchlochte Schuhleistenkeil	Axt
de Roever 2004	-	Hoge doorboorde schoenleestbijl	Rössener Breitkeil
De Grooth 2005	-	Doorboorde dissel	
Raemaekers 2005	-	Rössener breedwig / Breitkeil	
Raemaekers et al. 2011	-	Perforated wedges	
		Perforated shoe-last adze	Perforated broad wedge
Verhart in press	-	Perforated shoe-last axe	

imply a certain function, which could not be confirmed by use-wear analysis, the more neutral terms 'regular bipolar pieces', 'irregular bipolar pieces', and 'square shaped bipolar pieces' will be used here.

The definition of retouched pieces, *piece esquillée*, or *Ausgesplitterte Stücke* is partly the result of the overall morphological and technical characteristics of the artefact. It also relies on the analogy with experimental artefacts. The hypothesis that the pieces are wedges has been empirically tested in experimental researches (Ranere 1975). However, the microscopic evidence is rather problematic. That specific type of activity, in which the retouched piece is used as a wedge to split bone or other kinds of material, leads to the fragmentation of the used edge before use-traces are able to develop. Thus the edges where traces could develop chip off resulting in the loss of any possible traces. Therefore, they are not hard to define typologically but very hard to distinguish by use-wear analysis.

3.2.5 *The problematic nature of rounded pieces*

Another problem relates to the rounded pieces. As a result of the use-wear analyses conducted to examine these artefacts (see section 5.5), it can be stated that the rounding-off of an artefact's end or edge is the result of some sort of activity or process. The type of activity or the possibility that it might be some sort of postdepositional process is for use-wear specialists to identify. Nevertheless, the rounded pieces may be considered a specific group of

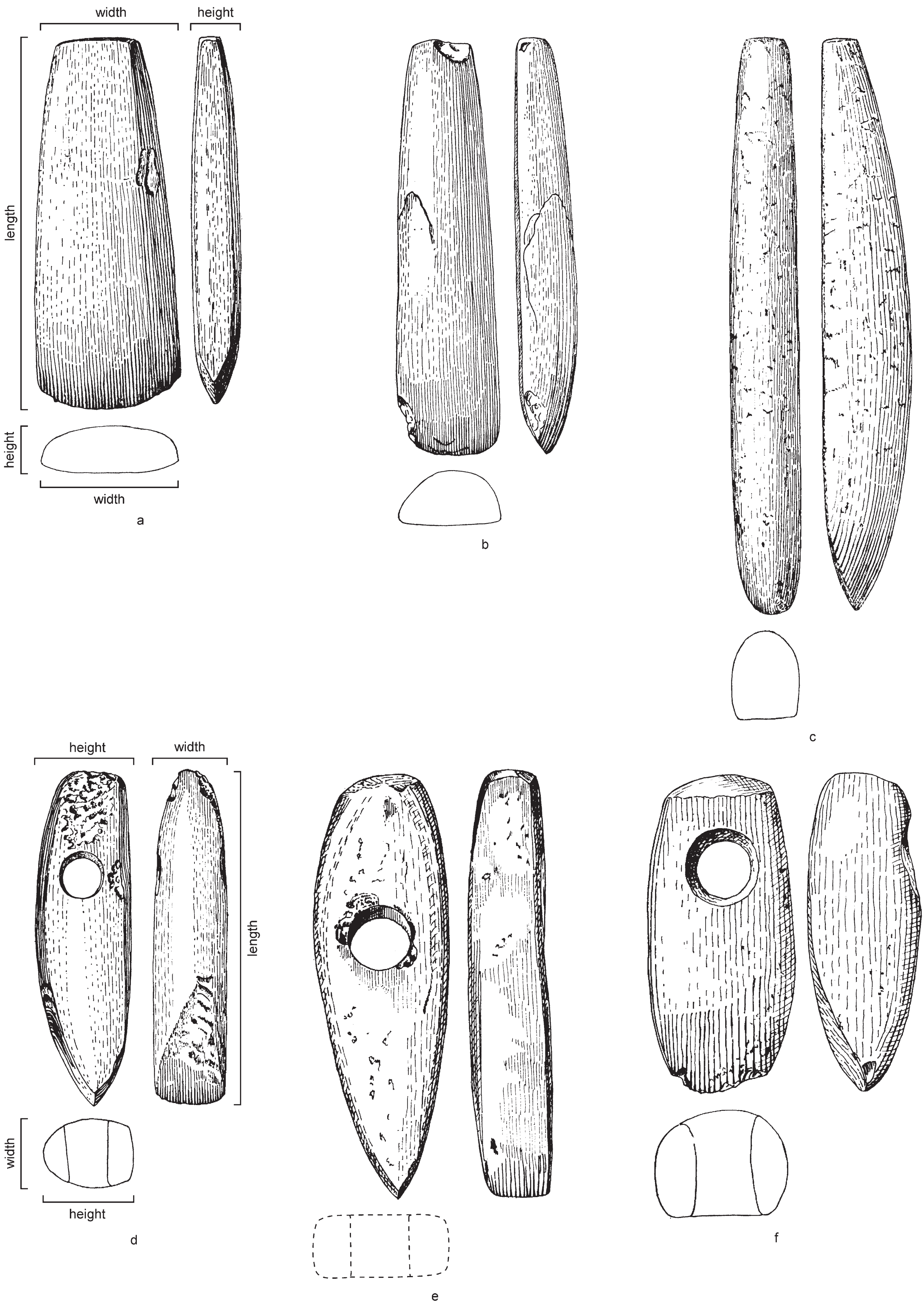


Figure 3.5 Different types of adzes and axes (taken from Brandt 1967): a: Flache Schuhleistenkeil, b: Mittelhohe Schuleistenkeil, c: Hohe Schuleistenkeil, d: Hohe durchlochte Schuhleistenkeil, e: Axte (or durchlochte Breitkeil), f: Plättbolz.

artefacts. The debate on the character of the activity that leads to this rounding is still on-going resulting in lack of clarity on how to define or classify these artefacts, as tools or not (see Devriendt 2008b, van Gijn 2008a, Woltinge et al. 2008).

Lacking an interpretive frame, we need to fall back to the typological definition of the rounded artefact. If a certain tool, a scraper for example, has a rounded working edge, that tool will be defined, and discussed, in the section on scrapers. If an artefact other than a tool, for example a flake or a blade, has a rounded end or edge, that artefact will be discussed in the section on rounded pieces. For further information see section 5.5.

3.2.6 The problematic nature of axes and adzes

The terminology to describe adzes and axes has been carelessly dealt with in the past. Several different terms are in circulation. One of the aspects leading to this problem might have been a translation issue, although a part of the confusion already existed within the German articles. The problem is threefold. First, there is the issue of terminology. Different terms are being used, in combination with different languages (table 3.1). Second, the orientation and description of the artefacts is dissimilar only adding to the confusion; and finally, there is the (presumed) function of the different tools.

First of all, and strictly speaking, the difference between an axe and an adze is the orientation of the cutting edge. An axe is characterised by the similar, perpendicular orientation of the cutting edge with the haft while an adze is characterised by the transverse orientation of the cutting edge to the haft. This is very clear when the artefact is perforated (figure 3.5 d and e versus f). When the axe or adze is not perforated its orientation as to how it should be hafted is less clear (figure 3.6 (flat) adze and 3.6 axe with rectangular cross section). A dissimilar use or function, as the result of the different hafting, may be presumed as well.

Regarding the terminology, several different terms are in circulation, both in English and in German but also in other languages. The main problem are the so-called *durchlochte Rössener Keile* (also see Raemaekers et al. 2011b). In my opinion Brandt (1967) makes an honest mistake of naming *Hohe durchlochte Schuhleistenkeile* after *Hohe Schuhleistenkeile*. The fact that the first is a stylistic variation of the second is seen by Brandt as a justification of such a terminology[3]. As the term *Schuhleistenkeil* was already in use before 1938 (Buttler 1938: 34), the use of the term by Brandt is an obvious one. Also, morphologically speaking there is a common ground between the two types, i.e. the combination of a flat side and convex side resulting in an asymmetrical cross section. But when the artefact is perforated and hafted, the orientation of the cutting edge changes dramatically, and thus possibly also its function. Instead of being hafted as an adze (*Hohe Schuhleistenkeil*, figure 3.5 c), the artefact changes position into that of an axe (*Hohe durchlochte Schuhleistenkeil*, figure 3.5 d). Although the axe is the general shape in which the artefact is hafted, its function is possibly that of a wedge (see below). From the 'German' point of view, their denomination as *Keil* is not entirely wrong; *Keil* is indeed translated as wedge. Brandt, however, did name the other type of perforated axe an Äxte, adding to the confusion, whereas Schwabedissen (1966/1967) referred to these as *Durchlochte Breitkeile*.

In English the two types of perforated axes are also referred to in different ways (table 3.1). Again, the term perforated (shoe-last) adze (Bakels 1987, Raemaekers 1999, Raemaekers et al. 2011b) is a logical derivation of un-perforated LBK adzes. Yet, in my opinion, confusion is eminent as they are not hafted as adzes, whereas the *Plättbolzen* as defined by Brandt (1967: 4-5), are hafted as such (figure 3.5 f).

The second issue results from the overall shape of the artefacts, especially the location of the perforation, and the way in which they are generally depicted. Adzes are depicted showing the full extent of their cutting edge first, placed at the left-hand side of an illustration, as this is their main feature (figure 3.5 a). In this way, the length is the distance between the butt and the cutting edge, the width is measured parallel to the cutting edge, whereas the height (or thickness) is measured perpendicular to the cutting edge. It is this height that is referred to in *Hohe Schuhleistenkeile* (figure 3.5 c).

As the main characteristic of the two types of perforated axes is the perforation itself, this is depicted at the left side of an illustration (figures 3.5 d and 3.5 e). The length, width, and height (or thickness) is measured in the same way as with the adzes, but because of the different orientation during the illustration of the artefact, the height appears to be the width in the picture. The resulting confusion of using the same system of taking measurements, by itself a good choice, is that with the perforated axes the height often exceeds the width. To make things even more confusing, the dimension, i.e. the height, which gives its name to the *Hohe durchlochte Schuhleistenkeile* also gives its name to the *Durchlochte Breitkeile*, yet for this type of tool the term *Breit* or breadth is used.

In this research the following dimensions will be used: the length is the distance between the butt and the cutting edge, the width is measured parallel to the cutting

3 Adzes *(Flache Schuhleistenkeile)* evolve to thicker specimens *(Mittelhohe* and *Hohe Schuleistenkeile)* which allows for perforation (Brandt 1967:10).

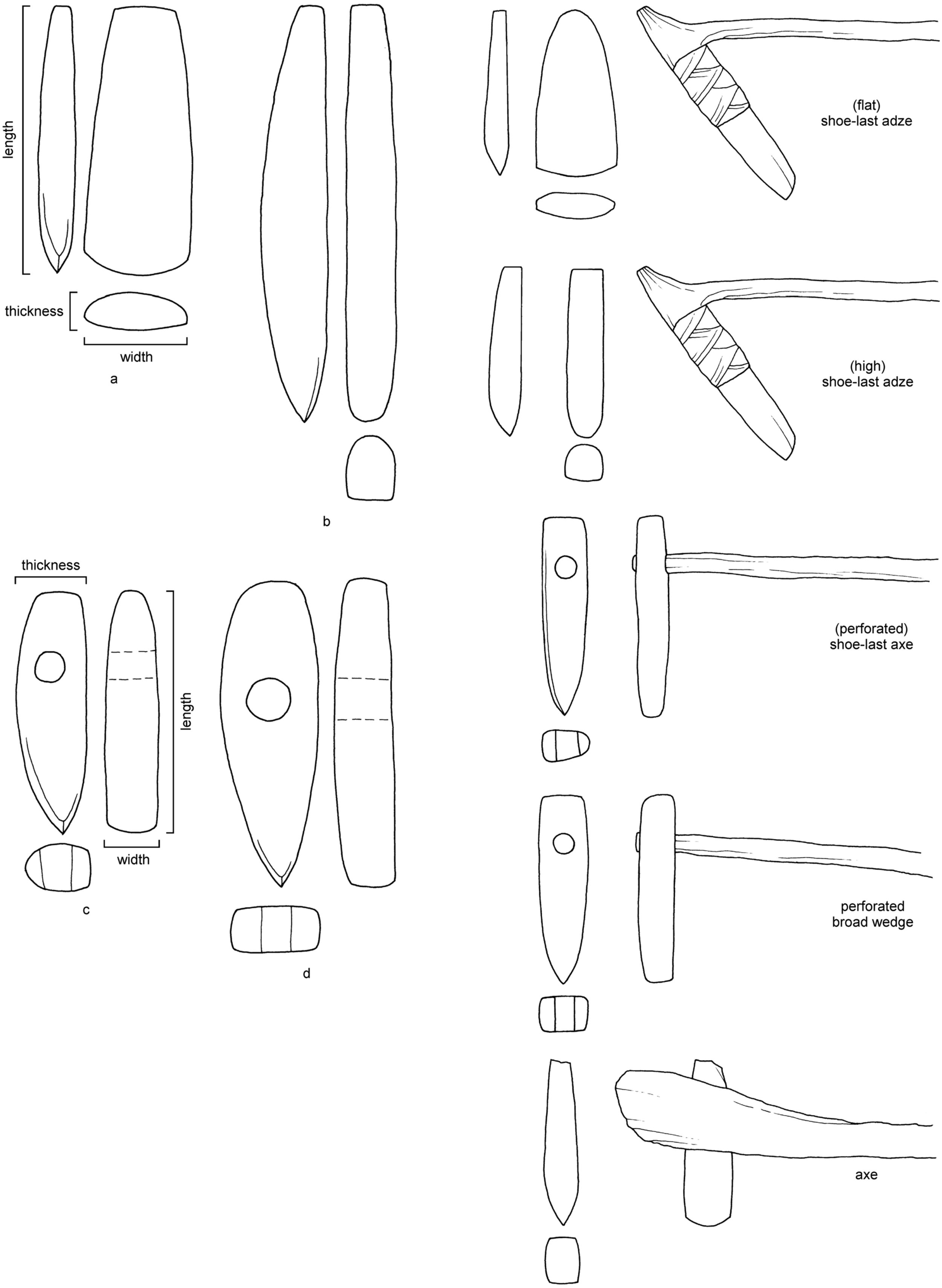


Figure 3.6 Measurement system applied in this study and development from adze to axe (adapted from Brandt 1967 and Raemaekers et al. 2011b): a: (flat) adze, b: (high) adze, c: shoe-last axe, d: shaft-hole axe.

edge, whereas the thickness[4] (height in most publications) is measured perpendicular to the cutting edge (figure 3.6).

Finally, the terminology implies a certain function as only certain activities can be performed with the tools at hand set by the technological characteristics of that specific tool. For example, an adze may be used to work an arable field whereas an axe may be used to cut down trees. However, as the precise function of perforated axes is still unknown, we may have to rely on presumptions, educated guesses and experimental research. It is believed that the tool is used as a wedge. Therefore the term perforated wedge is not ill chosen. On the other hand, it is only a presumed function. As the cutting edge is positioned parallel to the haft, the tool may also be used as an axe, for example to cut down trees in which case the term axe would be appropriate.

Thus to avoid confusion, I would argue that only three terms should be used, namely adzes, shoe-last axes, and shaft-hole axes. In this research, the term adze[5] will be used for the un-perforated artefacts from the LBK period (figure 3.6 a and 3.6 b). Depending on the author, one might divide them into two (Buttler 1938, Schietzel 1965), three (Bakels 1987, Brandt 1967) or even six (Modderman 1970) sub-classes based on the relationship between the thickness and the width. There is indeed no sense in using the length of adzes in any typological classification as the tool is often re-sharpened during its life (Dohrn-Ihmig 1983). From the Rössen culture onwards[6], two types of perforated axes appear side by side. The first will be called the shoe-last axe[7] (figure 3.6 c) after the *Schuhleistenkeile*. These axes are similar in shape to the *Schuhleistenkeile* and have the same asymmetrical cross section, referred to as D-shaped. The perforation is located at a third (Van der Waals 1972) or a quarter (Hoof 1970) along the length axis of the artefact and they have a long and slender shape (L = > 2.5 x H, < 3 x H). The second type of perforated axe, the shaft-hole axe[8] (figure 3.6 d), has a symmetrical cross section, referred to as a square with curved sides or double D. It is this more symmetrical shape that sets them aside from the shoe-last axes. The location of the perforation is situated more towards the middle of the length axis of the artefact, whereas its overall shape may be described as somewhat short and thick as their thickness (height) and width may be similar (L = > 1.5 x H, < 3 x H, general L = 2.5 x H) (Hoof 1970). With both tool types the perforation is initiated from one side resulting in a slightly conical perforation with straight edges, as opposed to a biconical or hourglass perforation made from two opposing sides.

Finally, it must be mentioned that the diversity within the group of shaft-hole axes is considerably larger than for the shoe-last axes (Brandt 1967, Van der Waals 1972). Also, some perforated axes cannot be attributed to a specific type as they are transitional forms.

Another type of axe is the axe with oval cross section[9]. As this is a different type of tool altogether, there is no confusion possible with the formerly discussed types, not even the adzes. The whole interpretation issue of axe versus adze, not to mention the possible function of the artefact (see below), applies to this artefact as well. Yet, as with most of the other tool types, the commonly used term is preferred.

The difference in typology between an axe and an adze results in more problematic issues. Even if functionality or function is of no relevance (see below), the use of one term or the other might be suggestive. This is especially so with fragments. Therefore the term “axe fragment” is used in this research when fragments are concerned. As adzes do not occur within the Swifterbant culture there is no reason to describe the fragments as axe/adze fragments. One might take this argument even further. When only the cutting edge of an axe fragment is found, it remains unclear whether it was perforated or not, complicating the matter even more. Even then, as there is no possible way of knowing, the term axe fragment will be used.

One might wonder if this whole debate is of any relevance to the functionality of the artefacts. Is an object hafted as an adze of lesser use than an object hafted as an axe? There is no reason to presume this to be true. As many of these

4 In imitation of the measuring system used in the flint analysis, the term thickness is preferred to height. It is also my opinion it is clearer and might minimize confusion.

5 The term hoe would also have been appropriate, especially as the term hoe-field is often used, yet an adze is a more commonly used term.

6 Shoe-last axes are found in Hinkelstein graves, while shaft-hole axes are found in Grossgartach contexts (Schepers 2006-2007). From the Rössen culture onwards, they are both found in the Netherlands.

7 This term is used in imitation of other English publications, and is the term most often used, although the term shoe-last wedge would be a more precise translation of the German word *Schuhliestenkeil,* and possibly is most closely related to its presumed function. The term shoe-last celt (Bakels 1987: 53) would also have been an appropriate term.

8 Even though the term shaft-hole axe may be somewhat confusing, the shoe-last axe has a shaft-hole as well, it is often used for this type of tool in English publications and is a wide spread term, therefore it will be used in this reasearch. The term broad wedge would be a more precise translation of the German word *Breitkeile*. As *Breitkeile* is not considered to be a correct term, the term broad wedge is not used either.

9 The term axe with oval cross section is translated from the German *Ovalbeile* while axe with rectangular cross section is translated from the German *Rechteckbeile* (Brandt 1967).

perforated axes are damaged and re-sharpened, the functionality of these tools is not questioned, their function, however, may be.

Bannenberg (1957) stated that a shoe-last axe cannot possibly be used as an axe because the elongated shape is hardly effective, the perforation is located too much to the back, and the cutting edge is too narrow. Experiments have shown that they are not very effective (Lessig 1999, Meier 1990, Vosgerau 1983/1984). But as most, if not all, of these artefacts are used, this seems unlikely. Even more, Müller-Beck (1965) made a reasonable case for the functionality and purposefulness of the asymmetrical shape. Thus, the main question remains: what are they used for? Each type, an axe, an adze, or a perforated axe, may be used for a specific task, yet, one type, for example the adze, may also be used for multiple tasks, i.e. cutting down a tree, hollowing out a canoe, or working an arable field. The wooden handle of a perforated axe may also be seen as a means to steady the artefact when used as a wedge or as the actual haft of an axe when used as an axe. The difference in definition is thus only related to the typology and has nothing to do with the presumed function of the artefact.

Over time, different functions have been put forward for the perforated tools. The definition as ploughshare, popular in the first half of the 20th century, is possibly the most disputed (Fischer 1982). For the number of scholars approving this interpretation, as many preferred the interpretation of hoe (Bannenberg 1957). The tools are most commonly interpreted in connection with agriculture, but are also interpreted as instruments to split wood (Linke 1980, Louwe Kooijmans 2005) thus as wedges (De Grooth 2005, Spatz 1999) immediately explaining the impact traces often observed on the butt. Sometimes they are simply interpreted as axe blades or related tools (Fischer 1982).

Recent experiments (Raemaekers et al. 2011b: 9-10) have, however, revealed that the tool was very suitable to cut down a tree, yet was far less suitable to split wood when it was used as a wedge. On the other hand, when the tool was turned over and used as a hammer, wooden wedges could be driven into the wood to split the tree. This proves that perforated axes are versatile tools to be used in an number of different tasks.

The symbolic value of the artefacts is also often given attention. Fischer (1982: 10) finds it hard to believe that axes he studied in Scandinavia only had a practical function. On the one hand, the imported specimens must have been as durable as the local axes made from local Scandinavian stone types, and they are not nearly as sharp as the flint axes. On the other hand, their shiny polished surfaces must have been very appealing and their raw material must have been proof of their exotic, i.e. imported, nature. Additionally, by analogy of ethnographical studies, their symbolic value as status indicators is suggested (Bakels 1987, Fischer 1982, Taffinder 1998, Verhart in prep.).

The above mentioned adzes and different types of axes are culturally and geographically dispersed in time. The adzes are typical for the LBK, whereas shoe-last axes and shaft-hole axes are introduced in Hinkelstein and Grossgartach[10] around 5000 BC (Farruggia 1993). From the Rössen culture onwards, both types of perforated axes are found in the Netherlands. Just as with the LBK adzes, the perforated axes are not only recovered from settlement sites and graves but are also found outside the loess belt in Late Mesolithic contexts, such as the Swifterbant culture and the Ertebølle culture. The perforated axes travelled even farther than the LBK adzes. This phenomenon is often explained as the result of transhumance, gift exchange or even theft (De Grooth 2005, Verhart 2000). One of the main differences between imported perforated axes and local copies is the shape of the perforation. Shoe-last axes and shaft-hole axes have a conical or straight perforation whereas local copies have a biconical or hourglass perforation (Klassen & Jonsson 1999, Fischer 1982). This technique of perforating an object by pecking or by using a solid drill from both sides is also seen on typical Mesolithic tools such as mace-heads (*Geröllkeulen*) and picks (*Spitzhauen*) (Beuker et al. 1992, Drenth & Niekus 2009).

During the Michelsberg culture the perforated axes were replaced by axes with oval cross section at around 4000 BC (Klassen 2002) and flint axes appear as well (Schut 1987, Louwe Kooijmans 2005). In the Funnel Beaker culture perforated axes are maintained in the form of flat hammer-axes and later battle-axes (Brandt 1967, Zápotócky 1992).

3.3 General observations and remarks on the stone assemblage

During the analysis of the stone artefacts, i.e. non-flint, several observations were made. The features that are significant for the material as a whole are discussed here. Any observations that refer to individual artefacts or a group of artefacts limited to one site are presented in chapter 4.

Excavations versus ditch slope inspections

Before the material is discussed, it should be mentioned that maybe not all artefacts are recovered from excavations at the archaeological sites presented in section 2.7. A number of finds may be the result of ditch slope inspections along the different parcels. To register the soil's stratigraphy and determine the agricultural value and potential of the newly created polder, the sections

10 The term *Rössener Breitkeile*, often used in the Netherlands (De Grooth 2005, de Roever 2004, Peeters et al. 2004) is thus culturally too narrowly defined.

of the polder ditches were inspected and drawn during which several sites were discovered. Additionally, as the ditches are 1.5 m deep, sites that are located even deeper were not discovered. During the course of this Ph.D. it was initially presumed that the material retrieved during these inspections was collected[11], bagged in white finds bags and immediately stored. The current analysis is the first reviewing of the material since it was put away in storage all those years ago. As the labelling of the material was done rather ambiguously with terms such as "*H46 kavelsloot zuid*", and as no other supplemental information is available, pinpointing the material to an archaeological site often proves to be a challenge. It seems that artefacts were bagged per ditch without any reference to the precise location in that ditch. Yet, careful deduction may give us a clue to what site the material originally belonged to.

The polders are transected by two types of ditches, *tochtsloten* or main ditches and *kavelsloten* or parcel ditches. The first type is the main ditch, also referred to as the *bermsloot* or shoulder ditch as these run parallel to the roads, the second type is the side ditch that drains the water from the fields and leads it to the shoulder ditches. In this way, it may be inferred which ditches around which parcels are intended, hence which sites the artefacts possibly belong to.

For three locations this deduction was needed. In the case of parcel G42 the reasoning was rather simple. As there are no other sites known on the parcel, there is no reason to believe the material belongs to any other site than to site S2.

Parcel G39 proved to be more challenging than first suspected. At the time of recovery the researchers labelled the bag with "*Tochtsloot S41*" or shoulder ditch S41 and this can thus be interpreted as material belonging to site S41. However, the material from site S41 is exposed in both sides of the ditch, thus in parcel G39 and G44. As Fokkens (1978) describes both cultural layers as belonging to one site, it is of no importance for the current state of affairs. However, the material labelled 'ditch between G43 and G44' belongs to site S6.

The final problem was parcel H46 where four different designations were used. The terms used are H46 parcel ditch north, H46 parcel ditch south, H46 shoulder ditch east, H46 shoulder ditch west. It is easily recognised that both 'parcel ditch' designations belong to the ditch where trench S21 is located and that the 'shoulder ditch' designation belong to the ditch where trench S22 is located. If this is assumed to be true, the terms north and south may apply to the two opposing sides of the ditch at trench S21, just as east and west are the two opposing sides in the ditch at trench S22. However, in contrast to the stone material, the flint material is abundant, and several small notes were found in the finds bags. It was consequently presumed that the possibility exists that the artefacts in the white finds bags from parcel H46 are the result of the 1962 and 1966 excavations by Van der Heide (see sections 2.7.7 and 2.7.8).

Comments regarding artefacts < 3 g

During the first phase of the analysis, a division is made between artefacts weighing 3 gram or more (≥ 3 g) and artefacts lighter than 3 gram (< 3 g) (see section 3.2.1). The group of artefacts < 3 g are mostly made up of small undeterminable pieces of stone such as small waste fragments resembling crumbs, or small indeterminate fragments. However, it cannot be ruled out that some of these pieces are in fact flakes or flake fragments that are no longer recognisable as such due to fragmentation or weathering.

A second observation recording the group of artefacts < 3g regards the consequences of the method of recuperation. This group of artefacts is made up of both hand collected and sieved material.

The hand collected material was three dimensionally registered, washed, labelled and bagged individually. However, very rarely some of the finds bags today hold two or three pieces of stone. Mostly these are to be refitted as one artefact, and are thus registered as one artefact. But sometimes refitting is no longer possible. Whether this is the result of inconsistent labelling and bagging in the past or the result of weathering of the artefact is no longer retraceable. Therefore, these multiple artefacts are registered by their actual number, although it may be presumed they originally formed only one artefact.

Things are even worse for the sieved material. The artefacts were obtained by processing the gathered soil in a concrete mixer before sieving. This may have led to the fragmentation and/or accidental bashing of the artefacts resulting in fractures and false impact traces. It is therefore not always possible to recognise true flakes and chips or even impact traces on the sieved material.

A final remark is that within this group, especially within the sieved material, some rounded quartz crystals occur. They have the appearance of very small gravel and may be up to 4-5 mm wide. As these do not occur on the levee sites, they may have been 'imported' from the river dunes where they occur naturally. De Roever (2009: 156) mentioned some of the pottery being tempered with sand making the transference of sand as temper a possible source. However, a more likely source is the corroded crystals from coarser-grained granites or similar stone types containing these quartz crystals or even the decaying of potsherds. Because none of these explanations can be attested, these little crystals have not been counted or

11 This was done in a selective manner as the material is very limited in number and only larger objects were retrieved.

weighed with the rest of the artefacts; they are not considered at all. Even if they were part of the artefact group their presence on the levee sites is of almost no significance as it concerns 9 pieces of gravel the size of pin-heads with an estimated weight of 0.01 or 0.02 g per piece.

Erratic debitage

A flake often has a small impact point on the butt. For the material from Swifterbant it has been observed that sometimes more than one impact point is visible on the butt or that impact traces may even be present on the dorsal side. This is most likely the result of unsuccessful or uncontrolled knapping or what is defined by me as 'erratic debitage'. It appears that when detaching flakes from the side of an object did not succeed, more attempts were made from all sides of the artefact. The impact points are randomly placed on and near rims and extremities, and also sometimes in the middle of surfaces, as if the knapper was frustrated at his unsuccessful attempts or tried to create fissures for easy detaching. It is a phenomenon also recorded on some of the indeterminate fragments and even on the tools.

The absence of rejuvenation pieces

With the flint assemblage, rejuvenation pieces are abundantly present. They are a well-defined artefact category and easy to recognise as different from flakes and blades. For the stone assemblage, this principle does not seem to hold. The absence of rejuvenation pieces within the stone industry is a rather remarkable aspect seeing that many chips and flakes, and a few blades and cores clearly indicate debitage. The coarseness of many stone types presumably impedes an easy recognition, yet if rejuvenation pieces were abundantly present, fine-grained specimens might be detected. It is thus more likely that they are not present, at least not in the same way as with the flint artefacts, i.e. as striking edge rejuvenation pieces.

Stone tool classification and terminology

One of the major problems of stone tool research is the variety of terminologies used during classification. As Hamon (2008: 1503) already pointed out, "the terms are as numerous as their geographical and cultural contexts of discovery". The complexity of the terminology relates to the fact that tool morphology and tool use basically are two different aspects. Yet terms often refer to both. The multi-functionality of tools, such as the combination of grinding and pounding, complicates the matter even further. Also, certain terms are often exclusively used in certain geographical or cultural contexts like "*manos*" and "*metates*" versus "grinders" and "querns". Definitions should therefore be carefully chosen and preferably elaborately described. In the article, Hamon (2008: table 1) presents an overview of the French, English, American, German, and Spanish terms used to designate grinding tools with the purpose of clarifying the differences. Afterwards, her own definitions are presented and explained. It are these terms and definitions, together with those of Adams (1996, 2002) on which the definitions used in this research are based.

A grinding tool consists of two separate tools or components that are interdependent. The hand-held part is often referred to as "grinder" or "handstone", and the stationary part is often referred to as "quern" or "slab". As the combination of "grinder" and "quern" is used in Linearbandkeramik and other fully agrarian contexts to define large grinding tools for cereal grinding that are often shaped by flaking and pecking, these terms will not be used in this study as they imply both function and cultural context. In a previous article (Devriendt 2008a) the more neutral terms "handstone" and "netherstone" were used. The definition of netherstone by Hamon (2008: 1503) as multifunctional tool need not jeopardise this. As for the function of most of the use-wear traces analysed, on grinding tools this did not result in a conclusive definition of any activities (see sections 4.5 and 4.6), so they may very well be multifunctional.

Other applied terms are hammerstones and anvils. Both tool types are characterised by the presence of impact traces or impact points on their surface. The difference in distribution is what sets them apart. Hammerstones have impact traces on their rims and extremities whereas anvils have impact traces often grouped together in the middle of a surface. Random impact traces on the surface may well be signs of the use as anvil, as the result of the use as hammerstone or even of pecking or roughening in the case of grinding stones. In this research it is considered as the result of the use as hammerstone because that is believed to be the more likely source. Processing something on an anvil requires stability and grip which is obtained by putting the object in the centre of the stone while the hand may rest on the side. The use of a hammerstone for flint knapping results indeed in impact traces on the extremities but other pounding activities may be carried out with a hammerstone too and these may very well lead to random impact points on the surface. However, it cannot be ruled out, that when only a few impact traces are visible, which are located randomly yet near the centre of a surface, this is the beginning of a grouped set indicating the use as anvil but not yet abundant enough to be recognised as such.

Combination tools are a mixture of tools combining two functions, such as hammerstone / grinding stones, hammerstone / anvils, and anvil / grinding stones, with tools combining three functions such as the hammerstone / anvils / grinding stones. This enumeration of one activity before the other, such as hammerstone before grinding stone, is purely arbitrary. It does not imply that one function, for example the hammer function, is more important than the grinding function; both have equal chances of being more dominantly present over the other. It does not imply either the sequence of use. The artefact may have been used simultaneously for different purposes or it may be used for one activity after another. Only when the artefact has been broken and re-used, can the sequence of functions be attested.

One of the most difficult definitions to make is the anvil / grinding stone combination. Both roughening and polishing may obscure the grouped impact traces in the middle of the surface. A shallow pit, present in the middle of the grinding surface, may confirm the definition as anvil. Yet, it was observed that some of these anvil / grinding stones have polish on the rims of the grinding surface implying they were used as handstones. Of course, this does not exclude the use as anvil, although one might imagine that the shallow pit may have been created to 'capture' the material, thus facilitating the grinding process.

Finally, cooking stones are not considered as a separate tool type in the typological list. Any type of stone artefact of a sufficient size may be used as a cooking stone, yet ethnographic analysis and experiments showed that certain stone types are preferred above others. Solid, firm and compact or cemented types such as sandstones, quartzitic sandstones, and quartzites are preferred to brittle types such as granites or gneisses (Beuker 1989). As a result of the use as cooking stones, these pebbles and cobbles are broken and often show traces of heat exposure (Duncan & Doleman 1991). Still, not all broken and burnt quartzite fragments are cooking stones. Heat alteration may be used to break up stones for easy access to minerals for temper production.

Discolouration versus heat exposure

Several grinding stones have a dark-brown to grey and sometimes even black discolouration of the working surface. The sides of some hammerstones show this discolouration as well. It can be defined as a sort of patina which covers the surface and does not penetrate the stone, like discolouration due to heat exposure does. One might think this is the result of chemical weathering in the soil. Artefacts lying in the soil can change colour over time as a result of the influence of iron, clayey soils or peat deposits. This phenomenon results in the discolouration of all the surfaces of the artefacts. As only parts of the surfaces are affected, it is my opinion this might be the result of the handling of the artefact. Most of these objects are handheld when they are used for processing food, working wood or other daily activities. This might result in the creation of a patina on the contact surfaces. This has not been analysed properly by testing or experimental reproduction and should therefore be further investigated.

The variation of impact points

It was observed that impact points on anvils may differ in shape and intensity. The shape can be round or elongated, while the impact traces can be light, intense or even very intense. The surface area of damaged crystals is also often related to the force of impact, thus with very intense impact traces the area of pulverised crystals is larger than with a light blow. Some of the intense impact traces are created by such a hard blow that crystals have been removed and the impact point is slightly hollowed out. Not only is the force of the blow a determining factor, also the nature of the contact material is of great importance.

Such a variation in impact points' shape or intensity was not observed for hammerstones. The intensity could only be deduced from the wear of the used surfaces.

Grinding stone fragments versus ground stone fragments

The ground stone fragments are a collection of polished pieces and polished flakes, and are set against the grinding stones and fragmented grinding stones. The division between grinding stone fragments and polished pieces seemed logical during the first phase of the analysis. During the second phase of the analysis, however, it appeared less practical and somewhat confusing as some artefacts are hard to place on one side or the other of the thin line dividing the grinding stone fragments from the polished pieces. However, in spite of the somewhat difficult analysis, it is important to maintain the partition for quantitative reasons. Therefore it is important to define the two types properly and elucidate why the partition is maintained.

A grinding stone can be complete, or it can be fragmented, but it will always be recognisable as (part of) a grinding stone. This means that it still has largely its original shape and only smaller parts are missing. The majority of the surfaces and sides are original surfaces whereas the minority are planes of fracture. Because of the largely original state of the artefact it can be determined which part of the grinding stone it originally was, for example the upper half or the whole side. Therefore, the grinding stone fragments are mostly rather large (> 50-70 mm).

Polished pieces or ground stone fragments are indeterminate stone fragments with a polished surface. They are defined separately because the majority of their surfaces and sides are planes of fracture whereas the minority are original surfaces. They are small (< 50-70 mm) and cannot be recognised as a specific part of a grinding stone. Only the polished surface gives a hint. Although it is presumed that they are small fragments of grinding stones, they are not defined as such; their small dimensions make this definition uncertain. Furthermore, if every polished piece was counted as a grinding stone this type of artefact would be over represented in the percentages of the toolkit.

Ornament typology
The ornaments studied in this research are divided into three categories: pendants, beads and fragments. The definitions used in this research are the following: a bead is perforated in the middle (centrically), with the perforation dividing the object in two, approximately equal halves. A pendant, on the other hand, is perforated at one end of the object (none centrically), with ¼ of the object on one side of the perforation and ¾ on the other. Hence, the pendant hangs with its largest part away from the string. Especially with small objects this division is not always easy to maintain.

For fragments it is self-evident that it is not always easy to determine whether they were originally part of a bead or a pendant. For whole ornaments, the same classification problem is sometimes true. Is a pendant still a pendant when it is worn as a central element in a necklace full of beads or when it is sewn on clothing? Much depends on how the object is worn. In an archaeological context we are often deprived of this aspect. Therefore we can only define the object by looking at the object itself. The definitions are thus based on the morphology of the object itself and consequently do not imply how it was worn or what function it fulfilled.

3.4 General observations and remarks on the flint assemblage

Throughout the examination of the flint material several observations were made. The observed features that are of a more general nature, i.e. significant for all or most of the flint artefacts or a certain artefact types, are described in this section. Any special features or characteristics that refer to individual artefacts or a group of artefacts limited to one site will be described in chapter 5.

'Retouches' on the distal end
Occasionally, the distal end of a flake, blade or other piece of debitage has little marks on the dorsal face. These marks resemble mostly irregular, abrupt retouches, like platform edge abrading or sometimes even very small flake scars. This may be the result of contact between the flake and the core during debitage (Newcomer 1976, Beuker 1983). In the light of the numerous bipolar pieces found on the sites, one might see them as a result of impact of the distal end of the artefact as it rested on an anvil. It may also be some sort of roughening so the artefact would have more grip on the anvil. These marks are mostly too small to be considered negatives of usable flakes. Therefore, they cannot be considered intentional debitage.

Retouches on the proximal end
On a fair amount of blades a small set of retouches were observed at the proximal end of the artefact. Mostly the retouch covers less than the top 10 mm of one of the edges, and is most often seen on the dorsal side. The blades may be retouched or not, or may even be blades with visible use-wear traces. This feature was observed on nearly all sites. The retouches are presumably related to the use of the artefact. It might be related to the hafting of the artefact or it might even provide the user of the blade a certain grip so the blade does not need to be hafted.

Retouched pieces versus artefacts with visible use-wear traces
Retouches can be very clear when they are well formed and regularly positioned but this does not always need to be the case. Marginal retouches also occur. These are small and more or less irregular, thus not always evenly sized and regularly positioned. The cause or origin of these marginal retouches is not always clear. It might be or not be the result of deliberate retouching. Usage can result in this type of edge damage as well, as can trampling or debitage attempts. Artefacts showing this type of irregular, marginal retouches over larger parts of the edge are defined as artefacts with visible use-wear traces. When they are restricted to a very small part of the edge they are defined as flakes or blades and received a note in the Special remarks box that they are damaged and/or used. Nevertheless, there are a small number that have presumably been defined as a tool, when retouches were invasive enough. The line between deliberate but irregular retouches and retouches as the result of use is vague and subjective.

Rejuvenation pieces versus blades
Some blades have a proximal part that resembles an ordinary blade and a medial and/or distal part that is clearly a striking edge rejuvenation piece. Presumably this is the result of a primary short striking edge rejuvenation blade followed by a secondary, longer blade detachment. The new and longer removal takes the remaining part of the edge of the striking platform with it. This results in a removal that can be defined as a blade or a rejuvenation piece alike. In this thesis it was decided to define them as striking edge rejuvenation pieces because it was still the intention to rejuvenate the edge of the striking platform regardless of an earlier, unsuccessful attempt.

Chips versus microchips
The presence of microchips, i.e. chips smaller than 5 mm, has not been recorded in this study. Since microchips are often used to define special activity sites such as knapping areas, it was considered to be useless to this research as spatial information is nearly always lacking. However, microchips are also used as an indicator of debitage at the site itself. Therefore, a close eye was kept on the possible presence of these small artefacts. It was observed that most microchips weigh between 0.01 and 0.03 g, and sometimes even up to 0.05 g depending on thickness. Their occurrence at the sites is estimated by analysing the weight classes. Every artefact weighing between 0.01 and

0.03 g may be a microchip. It is not an exact number, only a rough figure hinting at how many microchips there may be at a site.

Heat exposure and surface texture
During this research it was observed that a large number of the flint artefacts had been heavily exposed to heat evidenced by the grey or white discolouration. In most cases these artefacts are still discernible as flint. However, the surface of a minor part of them is different; it is no longer smooth. These artefacts have some sort of weathered surface varying from a sand-like to a coarser-grained surface. Small sparkles may shine through but the entire surface may shine as well; sometimes even as bright as a mirror-like gloss. Sometimes you have the impression that the artefact by itself is more granular and sometimes it appears as if the artefact is covered with a fine granular film or even a coarser-grained crust. This weathered surface is almost always present on the whole artefact, although not always to the same degree. It might also be present on the cortex or patina thus preventing definition. The changes are as varied as the artefacts are plentiful making it even more difficult to pronounce upon the matter. Of some of the artefacts it is believed they are flint, of others it is believed they may be quartzite, just because of this granular structure. Yet, this cannot be attested in any way without breaking or destroying them. Therefore, all artefacts showing this weathered, sandy surface are undefined by raw material type. As most artefacts are small, and fall within the non-diagnostic group of < 1 cm, this does not reflect upon the statistical representation. A remark was noted down, and they are entered in the flint database to keep them all together facilitating further research if this should be desirable.

3.5 Additional analyses

Several more analyses have been undertaken. One of these is the technical attribute analysis of the flint artefacts (see chapter 5). To keep this book conveniently arranged, information on additional analyses is kept together as much as possible. Therefore, the technical attribute analysis will be fully discussed in the flint chapter (see section 5.5). This applies to the analysis itself but also to the methodology applied.

Secondly, the specialised pilot-studies, using specific techniques, are performed by other researchers and therefore also addressed separately. These are the use-wear analyses and the residue analyses. Both are discussed in separate sections of the designated chapters. The use-wear analysis and residue analysis of the stone artefacts are discussed in sections 4.5 and 4.6 correspondingly, whereas the use-wear analysis on the flint artefacts is discussed in section 5.5.

Chapter 4

The analysis of the stone artefacts

4.1 Introduction

It is generally accepted that flint analysis can provide information about craft activities, subsistence, mobility, gift exchange, external contacts and contact regions, ideology and social interaction. The addition of artefacts produced out of a wider variety of stone types can offer so much supplementary information and yet, they are often not analysed.

Stone artefacts, produced out of raw material types other than flint, have received little attention in past and current archaeological studies[1]. This is partly related to the raw material type itself that easily obscures use-wear traces by its coarseness. It is, however, especially related to the lack of any form of manufacturing or shaping which renders grandeur to the object itself. Some types of flint implements, such as Neolithic daggers, are considered prestige items because of the high level of skill needed to produce them, often in combination with excessive time investment. These items appeal to our imagination and are happily selected for research. The lack of modification of most stone tools results in unattractive pieces of rock which are generally considered to be part of vague artefact categories (van Gijn & Houkes 2006). Stone implements demonstrating high production investment like polished axes and adzes or different types of querns have been extensively studied in the past and strengthen my point.

During the past decade new research impulses, initiated by a handful of specialists (e.g. Adams 1996, 2002; Dubreuil 2002, 2004; Hamon 2006, 2008; van Gijn & Houkes 2006), have resulted in a wider appreciation of the study and an acknowledgement of the problem. However, their attention is still mainly focussed on tools. Equal attention should be focussed on other artefact categories such as debitage material (e.g. Nieuwenhuis 2002). In combining both aspects, this study is part of this innovatory impulse and will largely contribute to the understanding of the vital role of the stone industry at Swifterbant.

1 Some of the rare exceptions in the Netherlands are the Betuwe Research Project and the Schipluiden excavation.

4.2 Artefact types and amounts

4.2.1 Total of all sites

A total number of 36,302 artefacts made of stone other than flint have been analysed. The artefacts, together weighing c. 195.9 kg, are divided into two groups based on their individual weight[2]. The first group consists of artefacts with a weight < 3 g and is made up of 32,413 pieces of stone weighing c. 8.2 kg. The second group consists of artefacts with a weight ≥ 3 g and is made up of 3889 pieces of stone weighing c. 187.7 g. The artefacts ≥ 3 g include 363 tools, 81 ornaments, 1473 pieces of debitage material, 1964 pieces of waste, and 8 other artefacts. The latter are more or less unexpected finds and were therefore not represented in the typological list; they include a stone with two indentations (site S2), a tool with a discus shape but of unknown function (site S3), three small amounts of Steinbrösel (site S3), two fragments of a macehead (trench S22), and an artefact in the shape of a bull's horn (trench S23).

It was observed that the preservation of the material is in general very good. The artefacts' fractures look fresh and most of the use-wear traces are well preserved. Some of the artefacts produced out of certain rock types, such as granite and gneiss, are crumbling or have even totally disintegrated into grit and dust. This is the result of the weathering of biotite due to humidity and moisture. Their occurrence is, however, limited. That this low number would be the result of the full disintegration under the influence of moisture is very unlikely as so many artefacts are preserved in good conditions. Also, if many granite objects had fully disintegrated more little pieces of quartz gravel (see section 3.3) would have been encountered in the sieved material.

The amount of poorly registered artefacts is limited to 740 pieces[3] (G42 and H46). S2 is located on the northern boundary of parcel G42. From this parcel a total of 128 artefacts have been found. The material presumably comes from the ditch between parcels G41 and G42,

2 For methodology see chapter 3; for typology see appendix 1; for a detailed description of the material see catalogue chapter 1.

3 During the long excavation and research history at the different sites an additional amount of artefacts was uncovered in the Swifterbant area. Unfortunately, it is no longer known which site they originally belonged to. Therefore, they are discussed in appendix 3.

the only place where the cultural layer can be accessed without extensive digging. On H46 a total of 96 artefacts were collected from an unknown location and 516 artefacts have been found in the two ditches alongside which trenches S21 and S22 were located.

We must bear in mind that it is possible that the material currently in our possession may not be the full amount of artefacts retrieved from these ditches. Because no finds administration remains today, it is unclear how many artefacts were retrieved originally, how many of them are analysed today and from which sites material might be missing. Unlike the flint material, we cannot compare the stone finds currently in our possession with the original amount because no information was published. We must assume that because nearly all the flint material is still present today, the same accounts for the stone material. In addition, the absence of research on the stone material is an advantage here; it reduces the chance of loss even more.

4.2.2 *Site S2*

General aspects

The material from site S2 combines artefacts from 8 excavation campaigns between 1964 and 2004 and presumably does not comprise material from a ditch slope inspection (see catalogue section 1.2.2). In total c. 460 m² was excavated which is roughly 58% of the site[4].

The stone assemblage is made up of 2625 artefacts < 3 g and 530 artefacts ≥ 3 g (table 4.1). The latter are defined as debitage material (36.2%), tools (7.0%), ornaments (4.9%), an indeterminate artefact type (0.2%), and waste material (51.7%). A variety of sixteen different stone types have been used, of which granite and quartzitic sandstone are used most regularly. Less often exploited stone types are gneiss, quartz, porphyry, and amber. For the tools and ornaments a more limited selection of stone types was used than for the debitage material. Only 38 artefacts (7%) were visibly exposed to heat.

Debitage material

This artefact category is a combination of 58 flakes, 1 blade, 99 chips, and 34 cores[5]. Most of the flakes are intact (70%) and have average measurements of 29x30x12 mm; exceptional lengths and widths are 72 mm and 60 mm correspondingly. The only stone blade found on the site is fragmented (52x25x6 mm) and has a rather regular appearance with a central ridge. The choice of quartzitic sandstone as raw material for this artefact, and the positioning of the impact point behind the central ridge, facilitated the longitudinal development of the detachment. As with the flakes, most of the chips are intact as well (70%); their average measurements are 13x12x5 mm. The group of cores predominantly consists of tested cores; cores with two opposing or three platforms occur only once. The final core is a core fragment that is, however, the biggest of all, measuring 87x55x33 mm. It was observed that the number of removals on the cores ranges between one and seven, all showing flake measurements (length-width ratio less than 1:2).

Table 4.1 Total number of artefacts per typological category of site S2.

	Number	%	% ≥ 3 g
Debitage material	**192**	**6.1%**	**36.2%**
Flakes	38	1.2%	
Flake fragments	20	0.6%	
Blade fragments	1	0.0%	
Chips	99	3.1%	
Cores	34	1.1%	
Tools	**37**	**1.2%**	**7.0%**
Hammerstones	2	0.1%	
Anvils	3	0.1%	
Grinding stones	6	0.2%	
Combination tools	5	0.2%	
Polished axe fragments	2	0.1%	
Ground stone fragments	19	0.6%	
Other	**1**	**0.0%**	**0.2%**
Ornaments	**26**	**0.8%**	**4.9%**
Waste	**274**	**8.7%**	**51.7%**
Indeterminate fragments	146	4.6%	
Pebbles / cobbles	96	3.0%	
Frost flakes / potlids	2	0.1%	
Possible debitage / tool	30	1.0%	
Subtotal ≥ 3 g	***530***	***16.8%***	***100%***
< 3 g	**2625**	**83.2%**	
Total	**3155**	**100%**	

Tools

The collection of tools consists of 2 hammerstones, 3 anvils, 6 grinding stones, 5 combination tools, 2 polished axe fragments, and 19 ground stone fragments (figure 4.1).

The two hammerstones are produced on pebbles of different quartzite types. Because of the small size and limited weight the first may be defined as retouchoir whereas the second one is more exceptional due to its elongated shape. The opposing impact traces on the long rims of the

4 The extent of the excavated area excludes the trenches in the back swamp areas.

5 For definition problems on flakes versus blades see section 3.1.2.

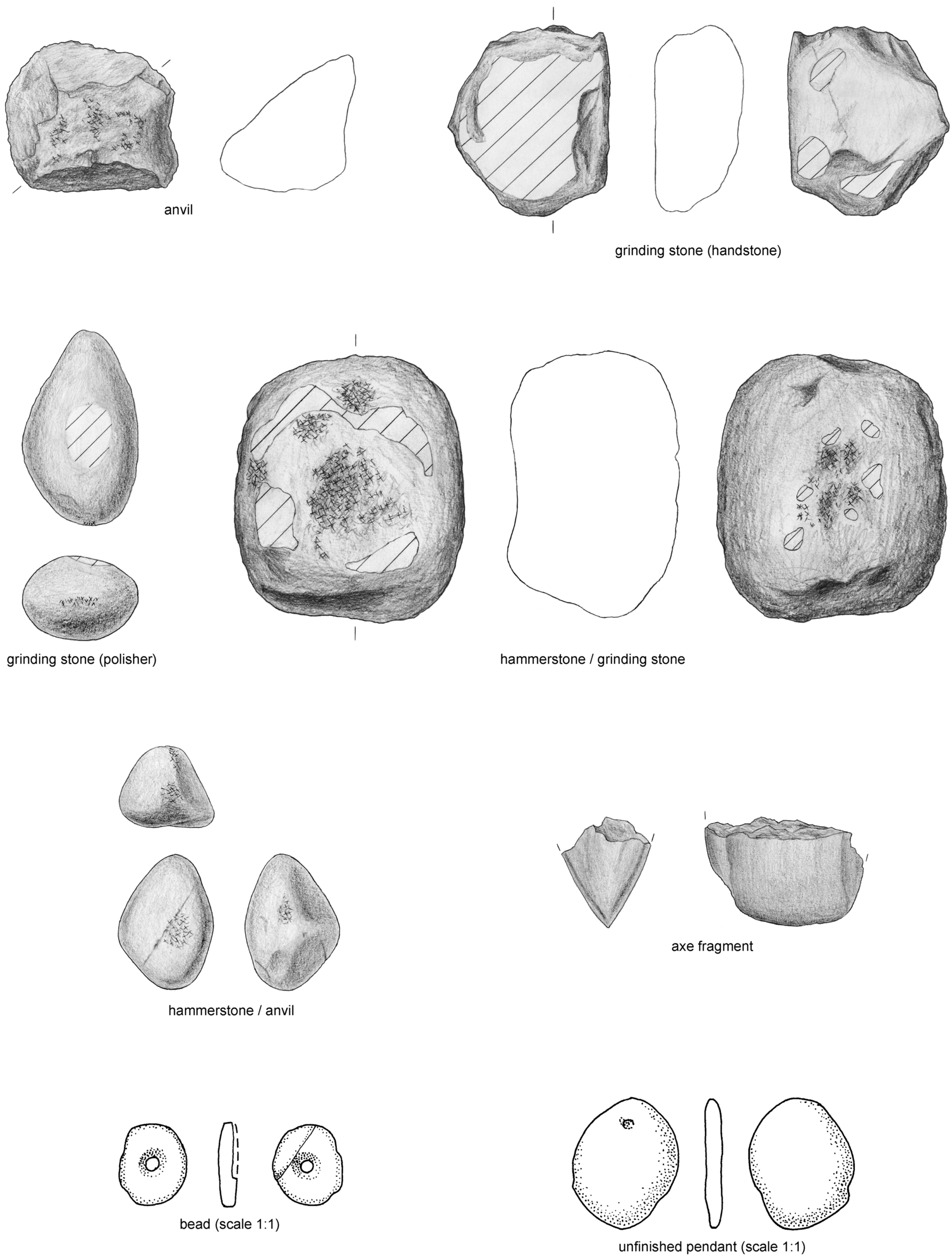


Figure 4.1 Overview of tool types and ornaments present at site S2. Scale 1:2 unless stated differently.

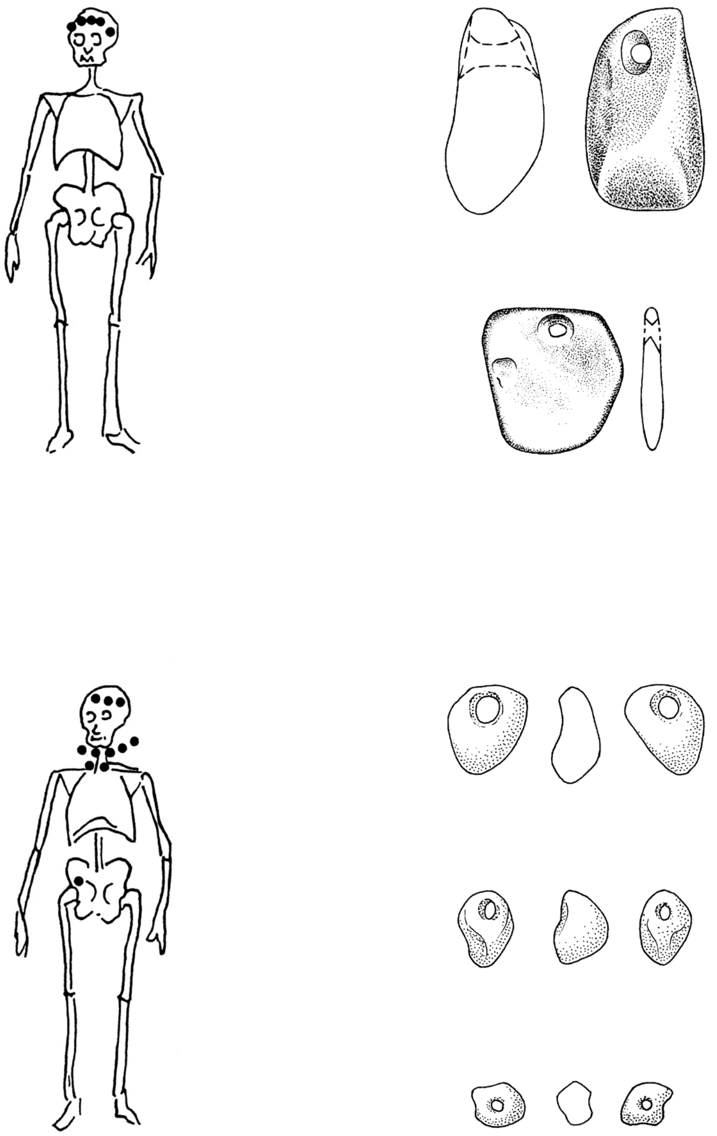


Figure 4.2 Selection of ornaments in graves V en XI. Scale 1:1.

artefact make a wider interpretation as a wedge or connecting piece possible.

The three anvils have triangular cross sections with the flat working surface opposing the tip of the artefact. The working surface shows in all three cases grouped impact traces in the middle. One of the anvils is presumably a reused core while another was used before and after deliberate fragmentation which occurred by debitage.

The grinding stones are a combination of a polisher and five grinding stones with two opposing flat surfaces or pyramid shapes. As nearly all of the latter are fragmented little can be said about their measurements or weight. Yet, they are presumably all handstones.

The combination tools are 2 hammerstone / grinding stones, 2 hammerstone / anvils, and 1 anvil / grinding stone. The three artefacts with an anvil function have triangular cross sections while the two others have two opposing flat surfaces. Their measurements range from 83x55x40 mm to 110x54x47 mm.

Of the two axe fragments the first is the cutting edge of a no longer definable axe type, while the other is broken through the hourglass perforation. Although the original shape of the latter can no longer be reconstructed, the hourglass perforation indicates a 'Mesolithic' or local origin instead of a 'Neolithic' or exotic origin (see section 3.2.6).

Finally, the ground stone fragments, 19 in total, indicate the high fragmentation rate of the grinding stones.

Ornaments

On this site a number of amber ornaments were recovered. They consist of 3 large pendants, 2 smaller pendants, 11

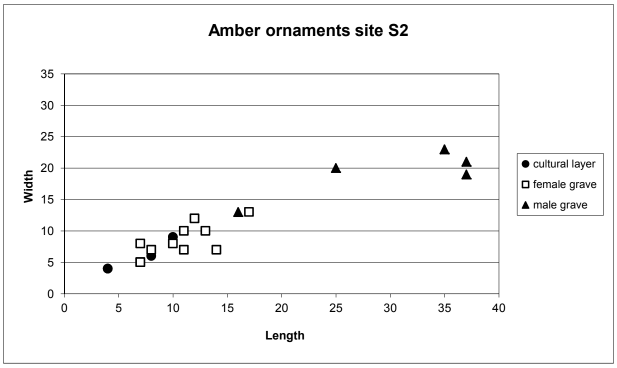


Figure 4.3 All amber ornaments of site S2.

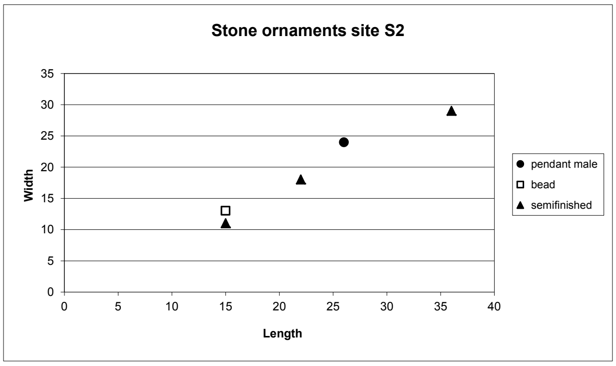


Figure 4.4 All non-amber stone ornaments of site S2.

whole beads and 5 fragments. Additionally, 5 stone ornaments and 1 tooth pendant were found as well.

Most amber ornaments were retrieved from graves V and IX (figure 4.2). They are all fabricated from natural lumps. Apart from the perforation, which is always made from two opposing sides, none of them was shaped or altered in any way. Size-wise there appears to be two size groups within these ornaments, regardless of their type (figure 4.3). Twelve of the ornaments form size group 1, a collection of gradually enlarging pieces with an average of 11x9x6 mm. The smallest specimen measures 7x5x3 mm, the largest 17x13x8 mm. The five ornament fragments all fall within the size limits of this first group. The three pendants buried with the man from grave IX (see catalogue section 1.2.2) make up the second size group. Their dimensions are very similar with average measurements of 36x21x16 mm. Only one bead stands isolated between both groups; it measures 25x20x19 mm. This is one of the two beads found in the man's grave (no. 4080). The other bead found in the man's grave (no. 4083) is the only 'male ornament' that falls within size group 1, even if it is at the edge. Although the woman is buried with twice as many ornaments than the man, it is clear that the largest pieces of amber belonged to him.

The group of stone ornaments, other than amber, is formed by the pendant in grave IX, the round bead and the three unfinished pendants. All except one are made out of (quartzitic) sandstone. The round, flat bead is made out of shale, the single artefact of this raw material type on this site. Partly because of their small number and partly because of their actual size, they do not form any particular size groups (figure 4.4).

The position of the ornaments on the bodies is rather striking. All the man's ornaments were strung around the head and neck, that is five amber ornaments strung around the (fore)head, a stone pendant that might have been part of this headband or can be considered some sort of ear ornamentation as it was recovered near the man's right ear, and a tooth pendant worn around the neck. The same applies for the woman who also wore all ornaments around the head and neck, except for one bead. Three ornaments were strung around the head and seven worn around the neck; the last ornament was found near her pelvis. Whether this was originally worn at the waist or fallen from her headband or necklace during burial is unknown.

Remaining stone material

A special artefact unlike any other artefact or tool found at the site is an oval piece of gneiss showing two large indentations at the sides. The artefact itself measures 144x135x60 mm, the indentations approximately 50/60x10 mm. The possibility is that it was shaped by debitage and that it was used as a weight, a net sinker or some other form of tool.

The largest group of artefacts at site S2 is the waste material comprising 146 indeterminate fragments, 96 cobbles and pebbles, 2 frost flakes, and 30 possible pieces of debitage / tools. The indeterminate fragments are an assortment of twelve different rock types making them the most varied collection of all the artefact types at the site. The cobbles and pebbles are a combination of more 'classic' oval pebbles and cobbles and a few flat pebbles. The first category has minimum and maximum measurements that cluster between 15x10x6 mm and 45x38x26 mm with larger specimens ranging up to 126x84x65 mm. The first group weighs between 3.3 g and 45.5 g while the larger specimens weigh up to 835.5 g and can be defined as cobbles. All the flat pebbles range from 21x16x4 mm to 51x32x9 mm with weights between 3.4 g and 18.5 g. The combination of these dimensions, weights, and their raw material type, make them all good candidates to be blanks for tools (oval pebbles and cobbles) or ornaments (flat pebbles). Finally, besides frost flakes possible pieces of debitage / tools occur as well. The latter are artefacts which possibly could be debitage material or even tools, yet their characteristics are not as diagnostic as one would like them to be.

Table 4.2 Total number of artefacts per typological category of site S3.

	Number	%	% ≥ 3 g
Debitage material	**951**	**8.8%**	**42.2%**
Flakes	225	2.1%	
Flake fragments	96	0.9%	
Blades	10	0.1%	
Blade fragments	2	0.0%	
Chips	473	4.4%	
Cores	145	1.3%	
Tools	**244**	**2.3%**	**10.8%**
Hammerstones	12	0.1%	
Anvils	21	0.2%	
Grinding stones	34	0.3%	
Combination tools	92	0.9%	
Polished axes	3	0.0%	
Polished axe fragments	7	0.1%	
Ground stone fragments	71	0.7%	
Retouched pieces	4	0.0%	
Other	**4**	**0.0%**	**0.2%**
Ornaments	**51**	**0.5%**	**2.3%**
Waste	**1005**	**9.3%**	**44.6%**
Indeterminate fragments	660	6.1%	
Pebbles / cobbles	232	2.1%	
Frost flakes / potlids	8	0.1%	
Possible debitage / tool	105	1.0%	
Subtotal ≥ 3 g	***2255***	***20.8%***	***100%***
< 3 g	**8563**	**79.2%**	
Total	**10818**	**100%**	

The last group, the grit or artefacts < 3 g, which make up 83% of all stone artefacts at the site, have the same general composition of stone types as the artefacts ≥ 3 g. The smallest pieces of 0.1 g and 0.2 g occur most often (34%); all the other weight classes are represented less frequently. Little fragments of white quartz and red granite, or at least red feldspar from red granite, were observed. As these two types of raw material are used as temper in the pottery (de Roever 2004: 46) these fragments may very well be the remnants of temper production.

Conclusion

The dominance of waste is substantial, debitage material occurs only half as often and tools take third place. For the debitage material, the high percentage of chips and low number of cores was observed. Also, the dominance of chips and flakes over blades is overwhelming. Site S2 is furthermore dominated by tools with a grinding function. This is not only the result of the high fragmentation rate of the grinding stones, that is 92% compared to 0% for the hammerstones, 33% for the anvils, and 20% for the combination tools, but also of their high number among the single activity tools. The number of axe fragments is low. Finally, a stone artefact with two indentations may be interpreted as a net sinker.

The correlation between the amber ornaments and the graves is striking; up to 16 of the 21 amber ornaments were found in graves. The presence of the cemetery in the first place points to a distinct function of the site that may be described as 'less residential'. By this I do not mean that cemeteries cannot be linked to a settlement, just that the archaeological reflexion of the range of activities at this site is less varied than one would expect it to be on a settlement site (also see appendix section 1.3).

4.2.3 Site S3

General aspects

The assemblage at site S3 is the result of several excavation campaigns on the site (1972 - 1978), as well as the material gathered from trenches S5 and S6. The core region of site S3 measures roughly between 630 m² and 760 m² depending on the estimated extent of the layer. Of this area approximately 430 m² is excavated (57% - 68%)[6].

The stone assemblage is a collection of 10,818 artefacts of which 8563 form a group weighing < 3 g and 2255 form a group weighing ≥ 3 g (table 4.2). The second group consists of debitage material (42.2%), tools (10.8%), ornaments (2.3%), indeterminate artefacts (0.2%), and waste (44.6%). Up to 25 different rock types have been used to produce the artefacts. This is the largest variety of types seen at any site in the Swifterbant area. Quartzitic sandstone and granite were clearly favoured over gneiss, quartzite, porphyry, and sandstone. The dominance of quartzitic sandstone over granite is mainly noticeable with the tools and the debitage material. A limited number of 204 artefacts (9%) were visibly exposed to heat.

Debitage material

The debitage material comprises 321 flakes, 12 blades, 473 chips, and 145 cores. Most of the flakes are intact (70%). Their dimensions gradually fan out from smaller ones to larger ones and have an average of 31x32x12 mm. Of the blades even more specimens are intact (83%) although their actual number is very low. The average measurements are 36x15x11 mm. The chips are also mainly intact (64%) and have average measurements of 15x14x5 mm. Noticeable is the high number of quartzite and quartzitic sandstone chips; even a fragment of a regular blade of 19x18x4 mm is observed amongst these chips. Also seven

6 In this calculation the extent of the excavated area excludes the parts of the trenches running into the creek.

chips of amber were counted (see below). Besides the ornaments, this is the only artefact type showing amber as well. The cores are mainly tested fragments; the specimens with one, two opposing, or multiple striking platforms are represented by a handful of each. All cores are defined as flake cores and have between three and eight removals per platform. Up to five specimens are actually tool fragments that are re-used as cores. It was observed that the tested cores are generally smaller than the other types of cores. Their average measurements are 42x33x22 mm and 77x62x48 mm correspondingly.

Tools

The tools are a mixed set of 12 hammerstones, 21 anvils, 34 grinding stones, 92 combination tools, 10 polished axes or fragments thereof, 4 retouched pieces, and 71 ground stone fragments (figure 4.5 – 4.8). Most of these tools are produced from different sizes of pebbles and cobbles, only a handful of them are re-used cores, re-used tool fragments, or indeterminate fragments. It was observed that re-used tool fragments do not necessarily have the same function before and after re-use.

For the hammerstones four oval pebbles and eight cobbles with two opposing flat surfaces were used. The small size and limited weight of the pebbles make an interpretation as retouchoirs plausible, especially as the intensity of the impact traces is generally less than on larger hammerstones. Some of the larger hammerstones are re-used tool fragments.

The anvils mainly have two opposing flat surfaces; triangular cross sections occur much less. The location of the grouped impact traces is often related to the general shape of the blank, which is in the middle of one or both of the two opposing flat surfaces or in the middle of the surface opposing the tip of the triangular tool. Shallow pits, natural or man-made, characterise the middle of some of the anvil's working surfaces. Some re-used tool fragments, deliberately broken or not, have been observed as well.

The grinding stones are defined as 29 handstones, 4 netherstones, and 1 polisher. The hand- and netherstones predominantly have two opposing flat surfaces of which one or both surfaces are used. Flake scars at the sides and impact traces on the rims show deliberate breakage, debitage or possibly even shaping of the artefacts. Only a handful of handstones deviates from this general image as a few have triangular cross sections, one has a convex working surface instead of the common flat surface, and another has a rather sharp angle between two adjoining grinding surfaces. Three out of the four netherstones are produced on slabs of stone, the final one has two opposing flat surfaces and is large and heavy, indicating a use as netherstone but the polish at the rims suggests a use as handstone. On one netherstone it was observed that the direction of use follows the bedding of the raw material unleashing as few crystals as possible. Two fragments of this grinding stone were retrieved on site S2, of which one could be refitted to the large fragment of site S3.

The combination tools comprise of 13 hammerstone / grinding stones, 59 hammerstone / anvils, 8 anvil / grinding stones, and 12 are a triple combination of hammerstone / anvil / grinding stone. These tools mainly have two opposing flat surfaces and to a lesser extend triangular cross sections. A handful of the hammerstone / grinding stone combinations are produced on pebbles and may be defined as *retouchoirs* / polishers. The gloss or polish on these pebbles is less developed than on the other hammerstone / grinding stones implying a different or less intense use. The hammerstone / anvil combination tools predominantly have grouped impact traces in the middle of one or two surfaces, sometimes joined by a shallow pit. Use-traces on three surfaces rarely occur. The anvil / grinding stone combinations are a group of tools with very diverse dimensions and weights, yet they nearly all have two opposing flat surfaces. Smoothed surfaces, grouped impact traces, and shallow pits characterise them in different arrangements. In two cases the pits are somewhat deeper compared to the others which might indicate a dissimilar use, use intensity or duration. The same applies to another tool that has some sort of crushed area in the middle of the working surface. The final type of combination tools, the hammerstone / anvil / grinding stones, display a nearly infinite combination of the above mentioned characteristics. Polished surfaces, impact traces, and shallow pits occur in a variety of intensities and locations.

The axes include two axes with oval cross section, a thin butted axe with oval cross section (Schut 1978, 1991), and seven fragments. The two oval axes are very alike, except for the two shallow pits in one of them. Both axes are largely covered by pecking traces. The thin butted oval axe is somewhat larger than the other two. The axe fragments are an assortment of different shapes and bits. Two fragments fit together forming the cutting edge of a shafthole axe. The artefact is broken through the perforation which is located at 49 mm from the cutting edge making it a rather short specimen. Another refit of two pieces is smaller yet more special. These fragments were found separately, one on site S3, the other on site S41, rare evidence that levee sites may have been occupied at the same time (see section 4.4). Together they form the perforated part of an axe. The perforation clearly has an hourglass shape. Another fragment may belong to this axe as they are made out of the same raw material, although they did not join. Another small piece of a polished axe most likely belongs to a fragmented axe. This fragment without much diagnostic features probably belongs to an axe found on site S4

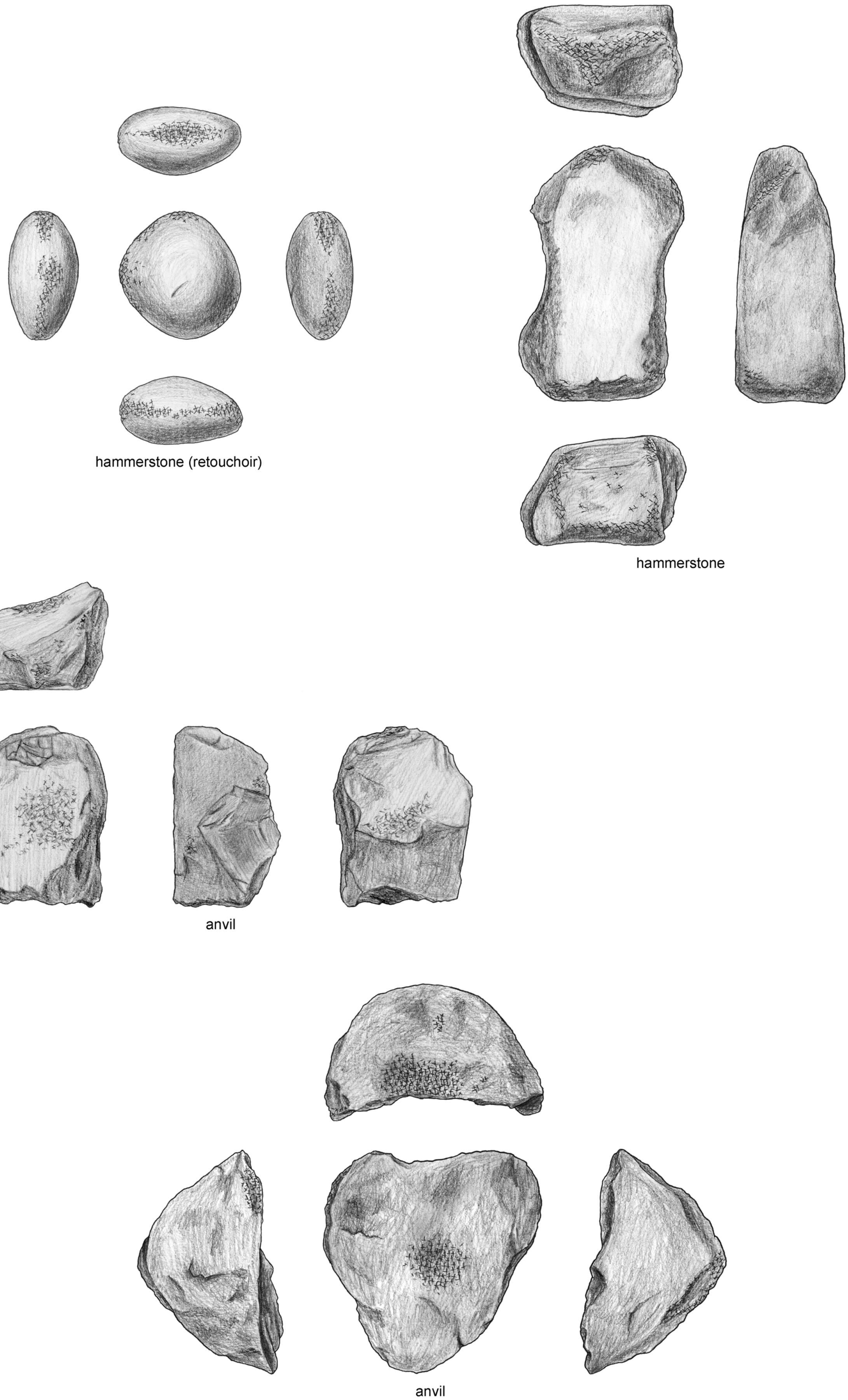


Figure 4.5 Overview of tool types present at site S3. Scale 1:2.

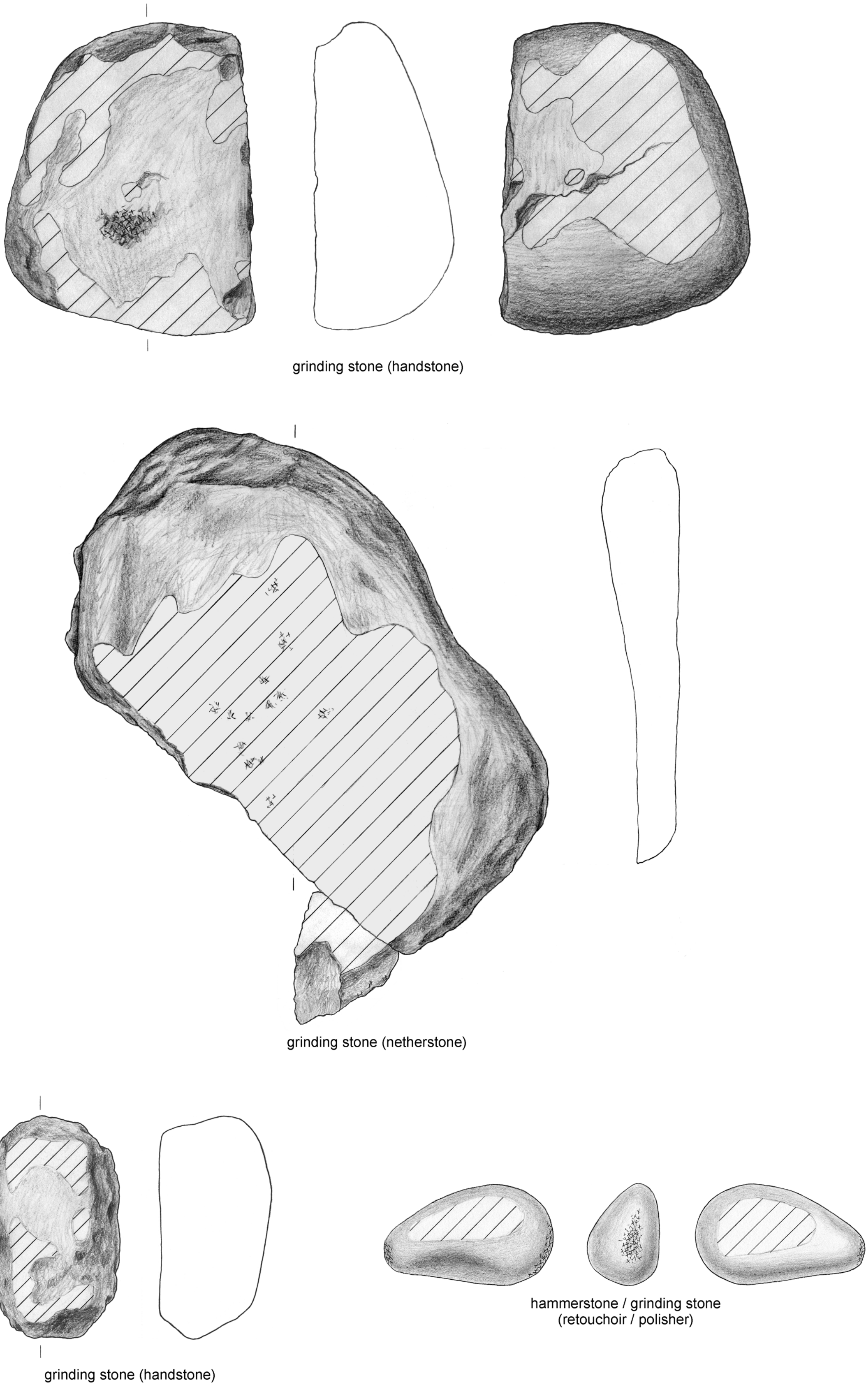


Figure 4.6 Overview of tool types present at site S3. Scale 1:2.

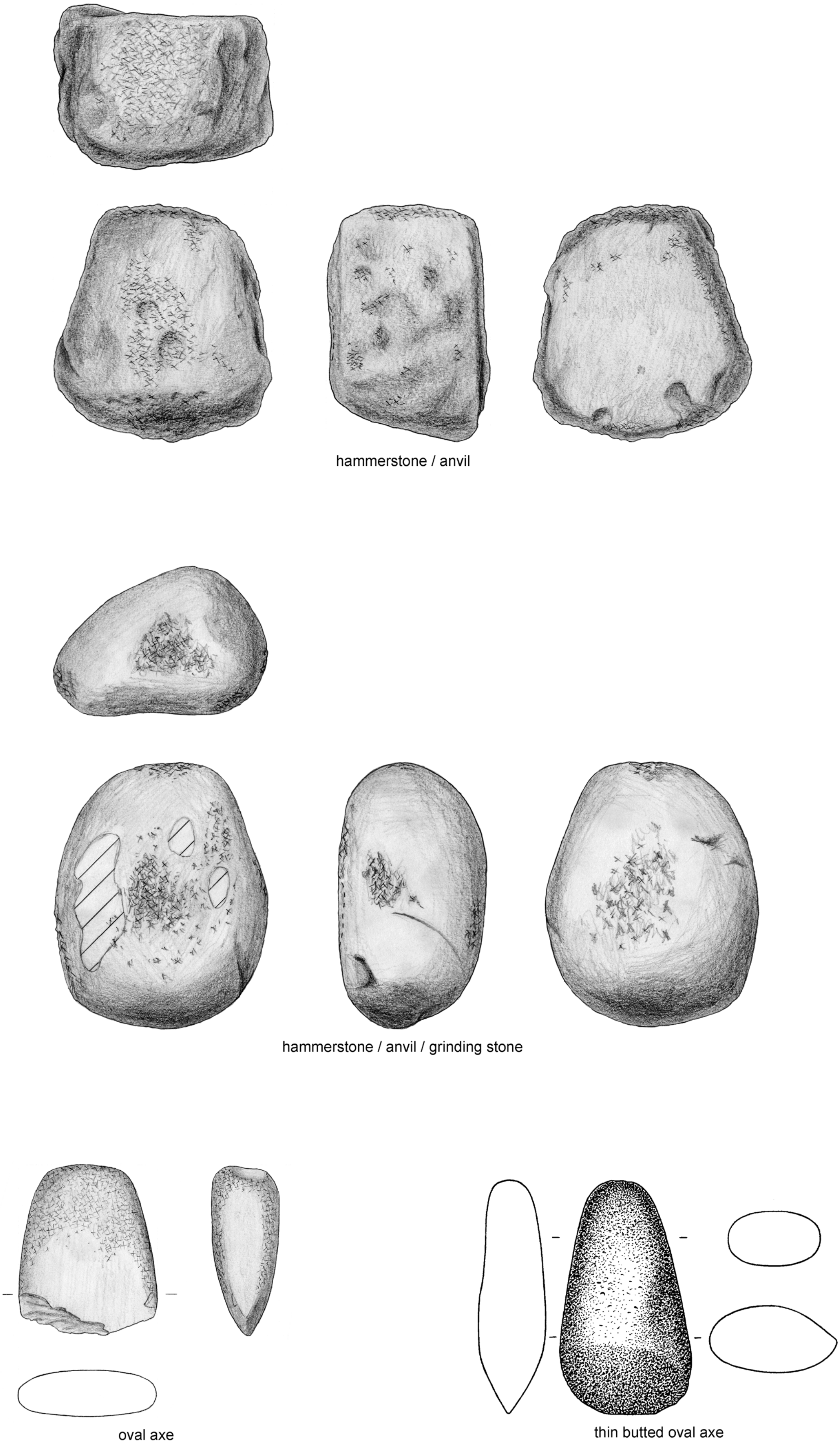


Figure 4.7 Overview of tool types present at site S3. Scale 1:2.

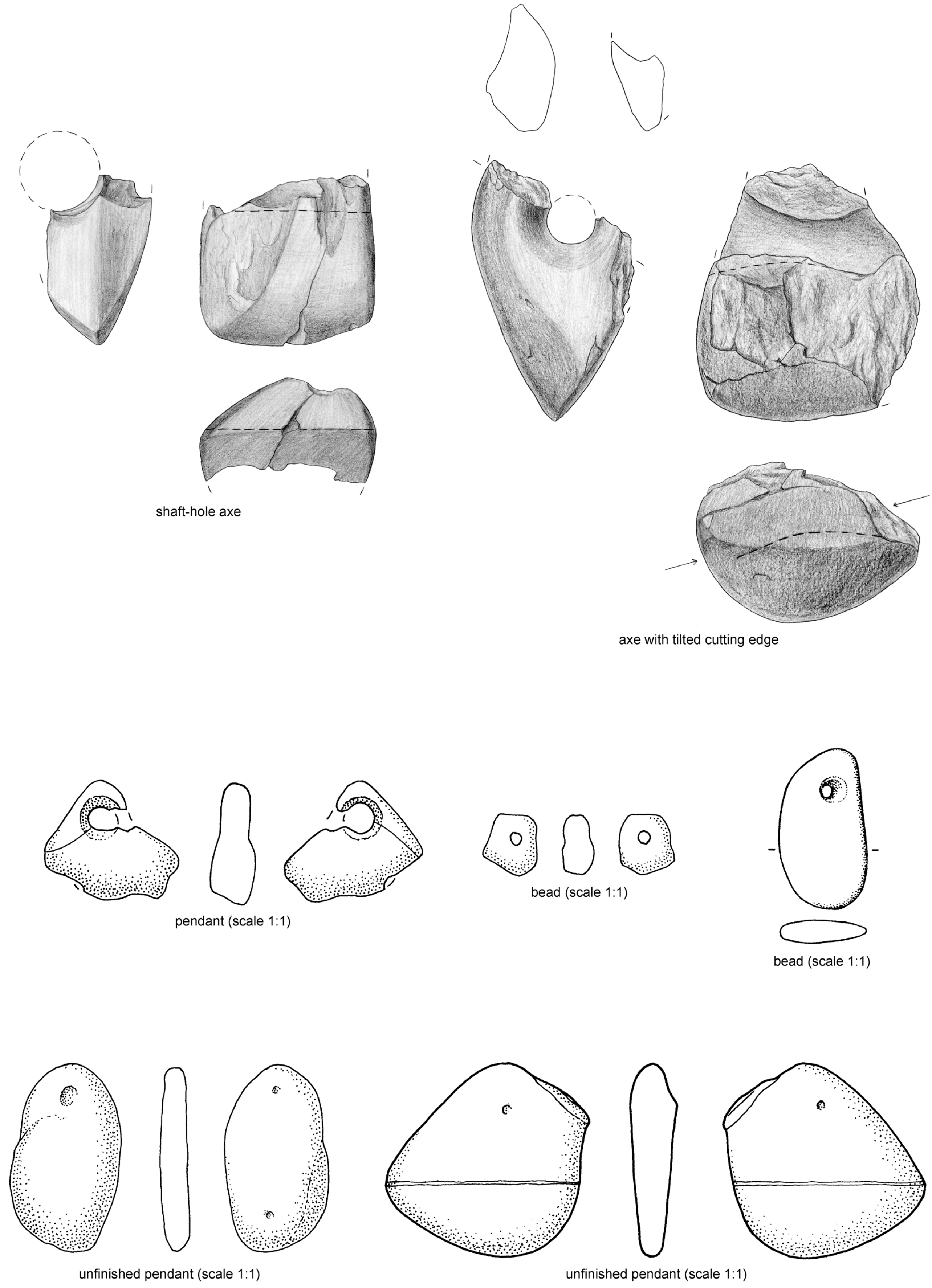


Figure 4.8 Overview of tool types and ornaments present at site S3. Scale 1:2 unless stated differently.

as it is made of exactly the same raw material (diabase, see section 4.2.4). Rather remarkable are two axe fragments, or rather fragmented axes as they are rather large, broken through the hourglass perforations which have a tilted orientation of the cutting edge. This rather odd shape did not prevent them from being used as is proven by friction polish in the perforation and the damaged cutting edge. These two axes are to be interpreted as local copies of the shaft-hole axes, yet of a specific kind (see section 4.8.2). A third axe fragment is also broken through the hourglass perforation, and thus considered a copy, but is weathered so heavily that it cannot be further described.

The four retouched pieces form a rare category as they are only found on this site. Also, no cores and only a small amount of debitage material of this type of raw material, a rough type of quartzite, occurs. These tools are defined as one scraper, two retouched blade fragments, and a fragment of a retouched edge. The scraper is an end scraper with one retouched edge produced on a flake. The two blade fragments fit together forming a retouched blade. The blade is regular in appearance with parallel edges and two parallel ridges. The little retouched edge fragment might have been a part of a truncated blade or even a trapeze.

Finally, the 71 ground stone fragments are a combination of flakes and indeterminate fragments with smoothed to polished surfaces. They are made up of all sorts of different shapes and measurements. Some flakes are rather big and others are better defined as chips. Yet, these detachments clearly point to deliberate fragmentation, debitage or shaping of the grinding stones they originally were part of.

Ornaments
The largest group of ornaments was recovered from this site. These consist of artefacts made out of amber, being 4 pendants, 12 beads, 13 ornament fragments and 7 chips (see above), and artefacts made out of stone, being 4 pendants, 1 bead fragment and 17 unfinished pendants.

The amber beads, fragments and chips form a tight size group measuring between 4 and 16 mm in length. All the pendants are larger and form a separate group, measuring between 21x10 mm and 29x23 mm. Noteworthy is the fact that these four pendants were discarded after they were broken. In some of the beads a second perforation was made after they were broken. None of the pendants show this feature. The thickness of the object is no limitation for doing so. Even the flat amber pendant no. 14609 shows no signs of a second perforation while it is only 4 mm thick. Although most of the complete ornaments have a thickness between 3 and 6 mm, some of the thicker ones, up to 10 and 12 mm are perforated meaning that technically it was possible. On the other hand, re-perforation is not a common practice as only three of all the 53 pendants, beads and fragments (6%) of the Swifterbant sites show traces of a second perforation.

Most of the stone pendants, bead fragment and unfinished pendants are made out of (quartzitic) sandstone (82%). The other raw materials used, all only once, are quartzite, quartz, radiolarian rock, and shale. It appears that the pebbles chosen for ornamental purposes all have rather similar sizes. They vary between 22 and 40 mm in length (average 32 mm) and 12 and 32 mm in width (average 23 mm). Only two pebbles are longer measuring up to 50 mm. These are part of the little group of pebbles that are elongated in shape instead of round or oval. The thickness of the pebbles clusters between 3 and 7 mm (flat pebbles); thicknesses of 10, 12 or 16 mm occur only once (classic pebbles). It was observed that the perforations of the stone ornaments are most likely begun by pecking and finished by drilling. Pendants have one perforation, rarely two, while the unfinished pendants have one or two holes, rarely four. Perforation attempts are abandoned because of the wrong choice of raw material, combined with large thicknesses, or because of the poor location or alignment of the perforations. Some of the pebbles have a quartz vein running through them. These pendants are perforated or oriented in such a way that the quartz vein runs horizontal.

Remaining stone material
Four artefacts are discussed separately because they are rare and have an unknown function. The first three are small amounts of grit and stone dust intermixed with sand, charcoal, and burnt bone. These are presumably collected like this as they were originally labelled as Steinbrösel. Yet, this gives no explanation to their function or reason for collection. The last artefact, measuring 77x74x29 mm, is shaped like a discus and shows centripetally positioned flake scars. The multiple impact traces around the rim may be a result of debitage but may also point to usage as hammerstone. However, as the shape is so different from all other hammerstones found at the Swifterbant sites, this functional interpretation may not be correct. More remarkable is its resemblance to a similar tool found at the site Kolhorn (see section 4.8.2). Drenth and Kars (1990) did not discover the function of that artefact either.

As on almost all sites, the waste material is the largest group of artefacts. These consist of 660 indeterminate fragments, 232 cobbles and pebbles, 5 frost flakes, 3 potlids, and 105 possible pieces of debitage material / tools. The indeterminate fragments are showing the largest variety of rock types found on any site at Swifterbant. One of them is the only fragment of radial pyrite (see figure 4.17). It has a radial crystal structure, measures 19x14x6 mm, and is showing the first signs of weathering. No traces of use were observed on the surface. The cobbles and pebbles are varying in size and are both oval and flat. The oval cobbles and pebbles have measurements ranging from 16x11x4 mm up to 119x84x62 mm, whereas the flat pebbles range from 23x14x3 mm to 51x40x15 mm. In combination with their weight and raw material, they would form good blanks for tools and ornaments. The remainder of the material are frost flakes, potlids, and possible pieces of debitage / tools. The latter are not characteristic enough to be actually defined as piece of debitage material or tools.

The final category is the grit. These artefacts < 3 g make up 79% of all stone artefacts found at the site and display a similar mixture of raw material types. The pieces weighing 0.4 g, 0.5 g, and 0.6 g are dominant with the individually weighed artefacts (20%). Little fragments of white quartz and red granite (feldspar) possibly indicate temper production while little chips of amber are fragments of ornaments.

Conclusion
Waste and debitage material are present in almost equally high numbers, while the tools occur far less. Amongst the debitage material the dominance of chips is attested, along with flakes, which both largely outnumber the blades. With the single activity tools the grinding stones outnumber the hammerstones and anvils, whereas the very high numbers of combination tools are dominated by hammerstone / anvils. When the tools are divided by function, and the ground stone fragments are excluded because it is impossible to determine how many grinding tools they represent, the result on site S3 is the dominance of anvil and hammer function over grinding function. The high number of axes, or fragments thereof, may be explained by the fact that the site is the largest site of all, with the thickest cultural layer, and was almost totally excavated. Even more, it may also be because of the prominently residential character of the site, i.e. artefacts representing a wide variety of activities associated with settlement sites. The large amount of debitage material and the presence of some tools also point in this direction. Additional finds are a disc shaped object, possibly to be interpreted as a core or some sort of hammerstone, and a fragment of radial pyrite.

The high number of ornaments found in the cultural layer is less easily explained. Intensive habitation of a site leads to the production (unfinished pendants) but also the loss (finished or fragmented beads and pendants) of many ornaments, yet one might expect the ornaments to be related to cemeteries as on sites S2 and S4, and trenches S21-S24. However, the amber bead from site S61 was also found in the cultural layer. As people presumably spent a lot of time at site S3, beads and pendants were presumably also lost.

4.2.4 Site S4

General aspects
The stone artefacts derive from one old excavation (1974) and several new excavations (2004 - 2007). The cultural layer extends over an area of approximately 425 m² to 600 m². The excavated area, calculated without the parts of the trenches running into the back swamp and the creek system, of roughly 140 m² is approximately 23% to 33% of the cultural layer.

The stone assemblage consist of 17,846 artefacts < 3 g and of 557 artefacts ≥ 3 g (table 4.3). The numerical superiority of the first group over the second is overwhelming (97% versus 3%). The artefacts ≥ 3 g are divided into debitage material (30.0%), tools (9.1%), an ornament (0.2%), and pieces of waste (60.7%). Of the twenty different stone types used, a preference for granite, quartzitic sandstone, and gneiss is observed. Less often exploited is porphyry. For the tools the same three dominant types are used regularly, especially quartzitic sandstone. Only a limited number of 20 artefacts have been exposed to heat (4%). In terms of percentage the tools are burned most often.

Table 4.3 Total number of artefacts per typological category of site S3.

	Number	%	% ≥ 3 g
Debitage material	**167**	**0.9%**	**30.0%**
Flakes	44	0.2%	
Flake fragments	11	0.1%	
Blades	1	0.0%	
Chips	85	0.5%	
Cores	26	0.1%	
Tools	**51**	**0.3%**	**9.2%**
Hammerstones	4	0.0%	
Anvils	8	0.0%	
Grinding stones	10	0.1%	
Combination tools	12	0.1%	
Polished axe fragments	5	0.0%	
Ground stone fragments	12	0.1%	
Ornaments	**1**	**0.0%**	**0.2%**
Waste	**338**	**1.8%**	**60.7%**
Indeterminate fragments	219	1.2%	
Pebbles / cobbles	49	0.3%	
Frost flakes / potlids	1	0.0%	
Possible debitage / tool	69	0.4%	
Subtotal ≥ 3 g	***557***	***3.0%***	***100%***
< 3 g	**17846**	**97.0%**	
Total	**18403**	**100%**	

Debitage material
The 167 pieces of debitage are a combination of 55 flakes, 1 blade, 85 chips, and 26 cores. Most of the flakes are intact (80%) and have average measurements of 31x32x11 mm. Still, a handful of flakes are rather large and measure over 47x50x15 mm. The single blade is intact and measures 56x26x9 mm. The positioning of the impact blow behind the central ridge must have caused the long length of the detachment, hence its definition as blade. Most of the chips are also intact (73%). These have average measurements of 15x14x4 mm. The cores are mainly tested fragments; in addition there are one core with one striking platform, two cores with opposing striking platforms, and one core with multiple striking platforms. The four latter have varying dimensions between 24x32x14 mm and 152x112x103 mm and are defined as flake cores with three to eight removals. It was observed that one of the chips is produced out of exactly the same raw material as the smallest core. Even though they could not be refitted, they indicate actual debitage at the site. For flint this is also clearly attested (see catalogue section 2.2.2 and catalogue plate 8, figure no. 82). The multiple impact traces near the rims of the largest of the four cores shows several unsuccessful debitage attempts. The tested fragments have one to three impact points or flake removals and have average measurements of 28x25x16 mm. It must be mentioned that one of them might have been split using the bipolar technique.

Tools
The set of 51 tools consist of 4 hammerstones, 8 anvils, 10 grinding stones, 12 combination tools, 5 polished axe / adze fragments, and 12 ground stone fragments (figure 4.9 – 4.10). Some of these tools' blanks are re-used cores or even re-used tool fragments. The dark-brown discolouration of at least four of the tools seems to be the result of handling.

The hammerstones all have different shapes and show a variety of traces. Two have impact traces around the rim, resulting in the removal of several small flakes, another shows old flake scars and intensive impact traces on the rims, and the final hammerstone is a re-used hammerstone / anvil fragment with a small but deep pit.

The anvils are a mixture of artefacts with two opposing flat surfaces and artefacts with a triangular cross section. The working surfaces, either one or two, all have grouped impact traces in the middle. A third working surface, that is more crushed than hammered on, and a shallow pit occur only once. Two of the triangular tools have a somewhat protruding working surface instead of the more common flat surface. The location and intensity of the impact traces is, however, the same as on all the other tools. Impact traces on the rims of some tools point to isolated debitage attempts.

The grinding stones are one polisher, six handstones, and three netherstones. The artefacts with two opposing flat surfaces clearly dominate. The handstones have one or two working surfaces showing smoothing or even patches of gloss. In addition, some isolated impact traces on the surface or near the rims may occur. One of the tools with triangular cross section has the general appearance of an axe, although it was presumably not used in such capacity as a sharp cutting edge is missing. The three netherstones are all fragments used in different intensities. One even has patches with a clear mirror-like gloss showing striations running in different directions. This distinctive gloss is the result of heavy wear which may also be the result of a different contact material. Flake scars on the sides of these grinding tools point to debitage or even deliberate fragmentation.

The combination tools are defined as one hammerstone / grinding stone, seven hammerstone / anvils, and three anvil / grinding stones. Again, these are dominated by artefacts with two opposing flat surfaces. Their traces are a combination of the characteristics visible on the single activity tools. Two of these combination tools have been found in situ at approximately 15 cm apart. The proximity of these two tools, and their general shape, suggest that they are the upper and lower parts of one grinding tool. The handstone has a convex working surface with a deep pit in the middle. One might interpret this pit as an anvil pit but it would also be convenient to 'capture' food, grain or other plant material in this pit during grinding.

The axe fragments are four fragments of the same axe and one flake of another axe. Of the four fragments two fit together forming a part of the cutting edge. The other two fragments could however not be refitted. These are the only artefacts made out of diabase at site S4. This raw material is very rare at the Swifterbant sites and it is therefore also argued that the axe fragment from site S3 belongs to this shattered axe as well, suggesting 'relative contemporaneous' use of both sites (see section 4.4). The fifth fragment is a broken flake of a polished quartzite axe. The dorsal face is totally covered with a bright polish and light striations.

The ground stone fragments are 71 indeterminate fragments and flakes with a smoothed to polished surface or area. Four of these artefacts also have impact traces, fresh planes of fracture and/or flake scars.

Ornaments
The only amber ornament found on the site is the tear shaped amber pendant in the child's grave. This naturally formed lump, measuring 14x10x7 mm, is characterised by an hourglass perforation. Unlike objects from the other graves found at the Swifterbant sites, this ornament was found near the right knee. This might be considered

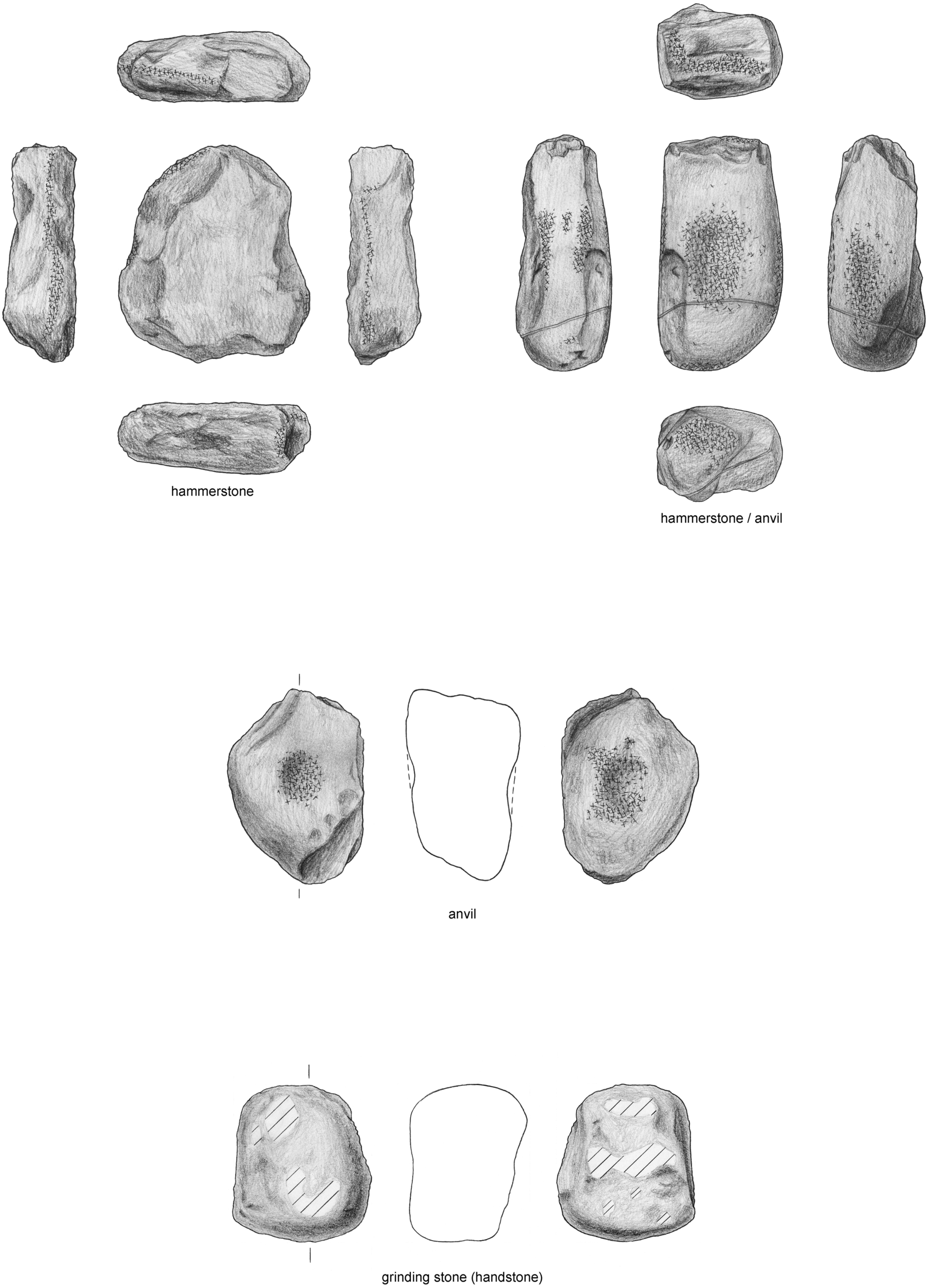


Figure 4.9 Overview of tool types present at site S4. Scale 1:2.

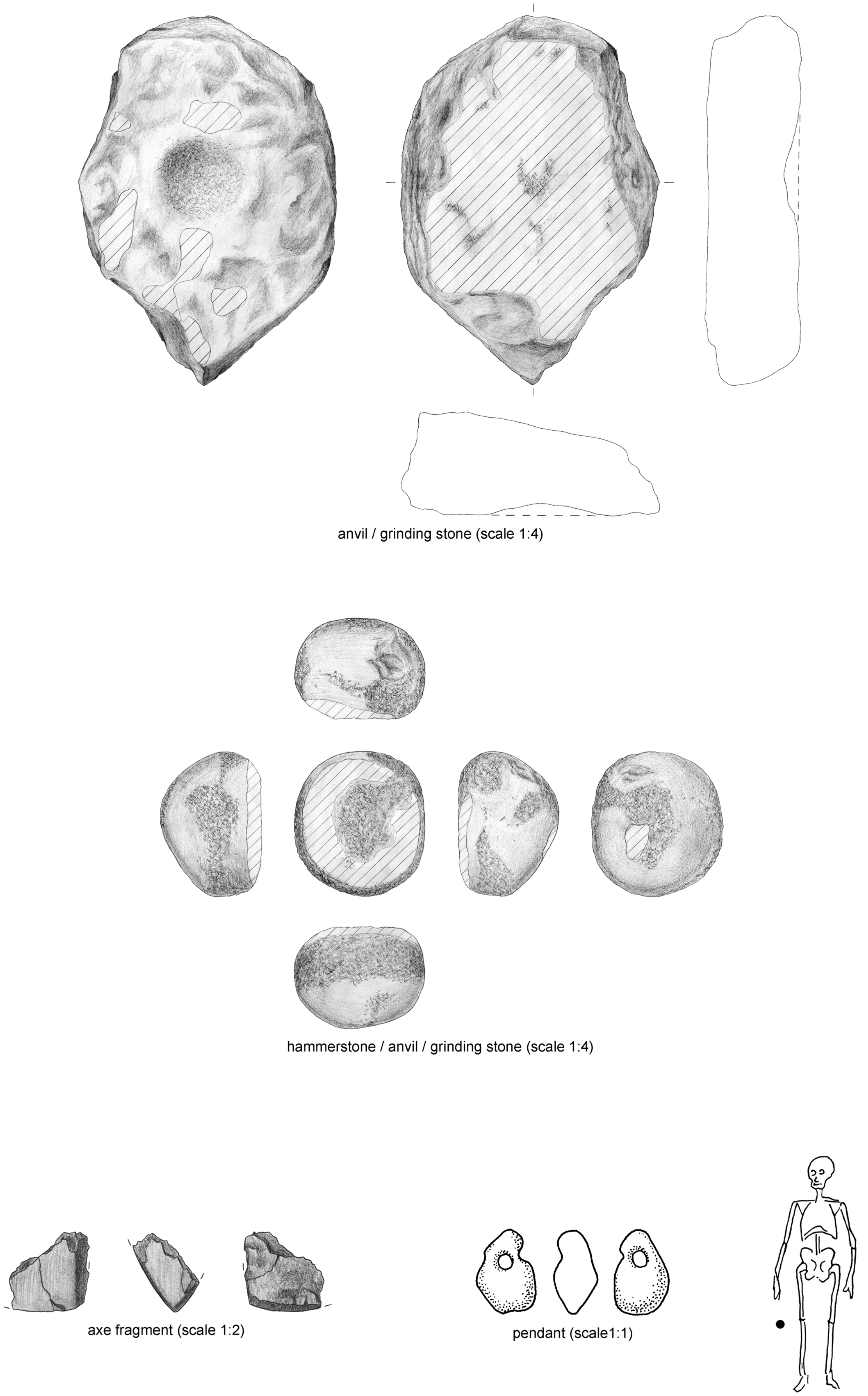


Figure 4.10 Overview of tool types and ornaments present at site S4.

a strange location as nearly all ornaments were retrieved from around the head and neck of the deceased. Because there are no other amber ornaments at site S4, it is highly unlikely that the pendant accidentally ended up in the grave with grave filling. Hence, it may be regarded as a grave gift or as the personal belongings of the child.

Remaining stone material

The predominance of the category of waste is clearly attested at this site. It is a collection of 219 indeterminate fragments, 49 cobbles and pebbles, 1 frost flake, and 69 possible pieces of debitage / tool. The indeterminate fragments show the widest variety of rock types at the site. Yet, it was observed that at least seven fragments may have belonged to exactly the same cobble of gneiss. The cobbles and pebbles form a more selective assemblage of raw materials, some of which are of southern origin. Their general shape is oval, while a limited number are flat (18%). One of the latter, made out of sandstone, may have an unfinished perforation. It is, however, so small, that it cannot be identified with certainty. Besides the frost flake, 69 artefacts may be defined as possible pieces of debitage material or tool fragments. Yet, their characteristics are insufficiently diagnostic.

The grit, or the 17,846 artefacts < 3 g, makes up 97% of all stone artefacts at the site. Most of the material was weighed in bulk limiting the representativeness of the numerical dominance of the weight classes. It is believed that the information content that would have resulted from the individual weighing of all 17,846 pieces would not justify the time invested, at least not for this study. The number of individually weighed artefacts per weight class shows a rather erratic distribution, although a general decline in numbers towards the heavier weight classes can be attested. The smallest pieces of 0.1 g, 0.2 g, and 0.3 g form 31% of the material. Fragments of white quartz and red granite (feldspar) are hardly observed.

Conclusion

The high number of artefacts < 3 g (97%) is one of the most prominent characteristics of site S4. This is especially remarkable as most of the soil of the 2005-2006 excavations[7] is not even sieved. Within the material from excavation strips 8 and 9, which are sieved areas, the percentages are 99.4% versus 0.6% for the artefacts < 3 g and the artefacts ≥ 3 g, whereas in the other strips this is 81.8% and 18.2% respectively. Even more, excavation strips 8 and 9 together hold more than 11 times as many artefacts than strips 0 to 7 together. If it is considered that strip 8 holds approximately 23% fewer artefacts than strip 9, and that strip 7 holds 97% fewer artefacts than strip 8, it may be presumed that roughly between 30,500 and 33,300 stone artefacts are missing.[8]

With the artefacts ≥ 3 g waste and debitage material occur most often, whereas tools take third place. The debitage material is dominated by chips and flakes, only one single blade was found. With the single activity tools the grinding stones outnumber the anvils and the hammerstones; the even more numerous combination tools are dominated by the hammerstone / anvils. When the tools are divided by function, and with the exclusion of the ground stone fragments, the anvils outnumber the grinding and the hammerstones. The medium amount of axes, or fragments thereof, is due to the high fragmentation rate of the diabase axe. An axe fragment found on site S3 most likely belongs to this diabase axe as well. Thus at site S4, evidence of only two separate axes has been found.

The only amber ornament was found in the only grave. It was argued that it was freshly made or at least not worn over a long period of time, which is consistent with the age of the young child (see section 4.5). Whether one grave can be considered a cemetery or not, the fact remains that a child was buried at the site. Combined with the archaeological remains in the main occupation layer, this points to a less residential character of the site, especially compared to site S3. Whether the hoe-fields, constructed before, during, and after the different phases of the main occupation is a discriminating factor is uncertain, as hoe-fields are established at site S2 and S3 as well. Whether all this is related to the high number of artefacts < 3 g, or whether that is just the result of a taphonomic phenomenon we do not yet understand, is still unsolved. Another aspect in favour of the rather special interpretation of the site is the grinding tool of two matching pieces recovered in situ. In combination with the shattered pot found close by, this is such a rare find that in many archaeological works it would be ritually interpreted. The three artefacts together do provoke the image of some sort of agricultural ritual or deposit. Still, there is no thread of proof that these three artefacts indeed belong together.

4.2.5 Trenches S21-S24 and parcel H46

General aspects

The artefacts from these trenches are the product of several excavations. A part of the material may possibly be from two ditch slope inspections although it is also possible it was retrieved from the earliest excavations at the site (see sections 2.7.7 and 2.7.8). The river dune surface is estimated at 5275 m² of which two tops lightly protrude. The four trenches cover an area of c. 850 m² to 880 m² which is approximately 16% - 17% of the dune's surface.

7 The excavation trench was divided into 10 long strips of 0.5 m wide, of which the soil from strips 8 and 9 was integrally sieved over 2 mm meshes while strips 0 to 7 were excavated by shovelling (see section 2.7.4).

8 These calculations also take into account the differences in terms of percentages between lines 0 and 7.

Table 4.4 Total number of artefacts per typological category of trenches S21-S24.

	Number	%	% ≥ 3 g
Debitage material	**126**	**11.8%**	**26.5%**
Flakes	54	5.1%	
Flake fragments	17	1.6%	
Blades	1	0.1%	
Blade fragments	1	0.1%	
Chips	42	3.9%	
Cores	11	1.0%	
Tools	**17**	**1.6%**	**3.6%**
Hammerstones	2	0.2%	
Anvils	3	0.3%	
Combination tools	8	0.8%	
Polished axe fragments	1	0.1%	
Ground stone fragments	3	0.3%	
Other	**3**	**0.3%**	**0.6%**
Ornaments	**1**	**0.1%**	**0.2%**
Waste	**328**	**30.8%**	**69.1%**
Indeterminate fragments	136	12.8%	
Pebbles / cobbles	162	15.2%	
Possible debitage / tool	30	2.8%	
Subtotal ≥ 3 g	***475***	***44.6%***	***100%***
< 3 g	**590**	**55.4%**	
Total	**1065**	**100%**	

The stone artefacts consist of 590 artefacts < 3 g and 475 artefacts ≥ 3 g (table 4.4). The artefacts ≥ 3 g are defined as pieces of debitage material (11.8%), tools (1.6%), an ornament (0.1%), other artefacts (0.3%), and pieces of waste (30.8%). In total eighteen different rock types have been employed of which the different types of quartzite were clearly preferred. The only artefact of jet found on all the Swifterbant sites, is the jet pendant from grave I in trench S22. Heat exposure is rare at the site, it was observed with 4% of the artefacts ≥ 3 g.

Debitage material

This artefact category comprises 71 flakes, 2 blades, 42 chips, and 11 cores. Most of the flakes are intact (76%) and cluster between 16x16x5 mm and 50x57x20 mm. The average measurements of these intact specimens are 31x33x10 mm. The blade that is intact measures 35x16x9 mm; the other is damaged. Most of the chips are intact as well (76%). Here the average measurements are 16x16x5 mm. The cores are defined as one core with multiple striking platforms and ten tested fragments. The first has up to four removals per striking platform and measures 73x58x84 mm, the others have one to four impact points and/or removals and average measurements of 55x45x11 mm.

Tools

The small number of tools are defined as 2 hammerstones, 3 anvils, 8 combination tools, 1 axe fragment, and 3 ground stone fragments (figure 4.11). For these tools mainly cobbles with two opposing flat surfaces were used, and to a lesser extent pebbles.

Both hammerstones may be referred to as retouchoirs as they are produced on pebbles. Still, one of them shows a rather large flake scar on one extremity as the result of use; the flake could later be refitted as it was found within the remainder of the material. One might wonder if simple retouching would have led to the detachment of such a flake. Maybe these small hammerstone pebbles were used with more force than initially imagined.

The three anvils are all broken. Only one can clearly be defined as a remnant of a cobble with two opposing flat surfaces. The anvils show impact traces in the centre of one or both surfaces; one even has a small anvil pit.

The combination tools are six hammerstone / anvil combinations and two hammerstone / anvil / grinding stone combinations. The hammerstone / anvils all have two opposing flat surfaces, yet their dimensions vary significantly. Grouped impact traces in the middle of one working surface occur most, often in combination with impact traces on the extremities; only once do the two opposing surfaces show traces of use. A shallow pit in the middle of an anvil was observed once. The first hammerstone / anvil / grinding stone combination has intensive impact traces around the rim and two smoothed surfaces with light impact traces in the middle. As it is produced on a pebble it is more likely to be a polisher than be a part of a grinding tool. The second hammerstone / anvil / grinding stone combination is roughly twice as large, has two opposing flat surfaces with impact traces in the middle and one smoothed surface. As the tool weighs up to c. 450 g it possible has a different function as the one made out of a pebble.

The axe fragment is a flake of what appears to be the side of an axe made of amphibolite. At the proximal end the flake has a concave delineation which can be interpreted as the edge of the perforation. The question remains whether such a flake can be detached as the result of usage, or whether it was chipped off after the artefact broke across the perforation.

The three ground stone fragments are indeterminate fragments with a smoothed or polished area. The surface of one of them is not just smoothed but used rather intensely

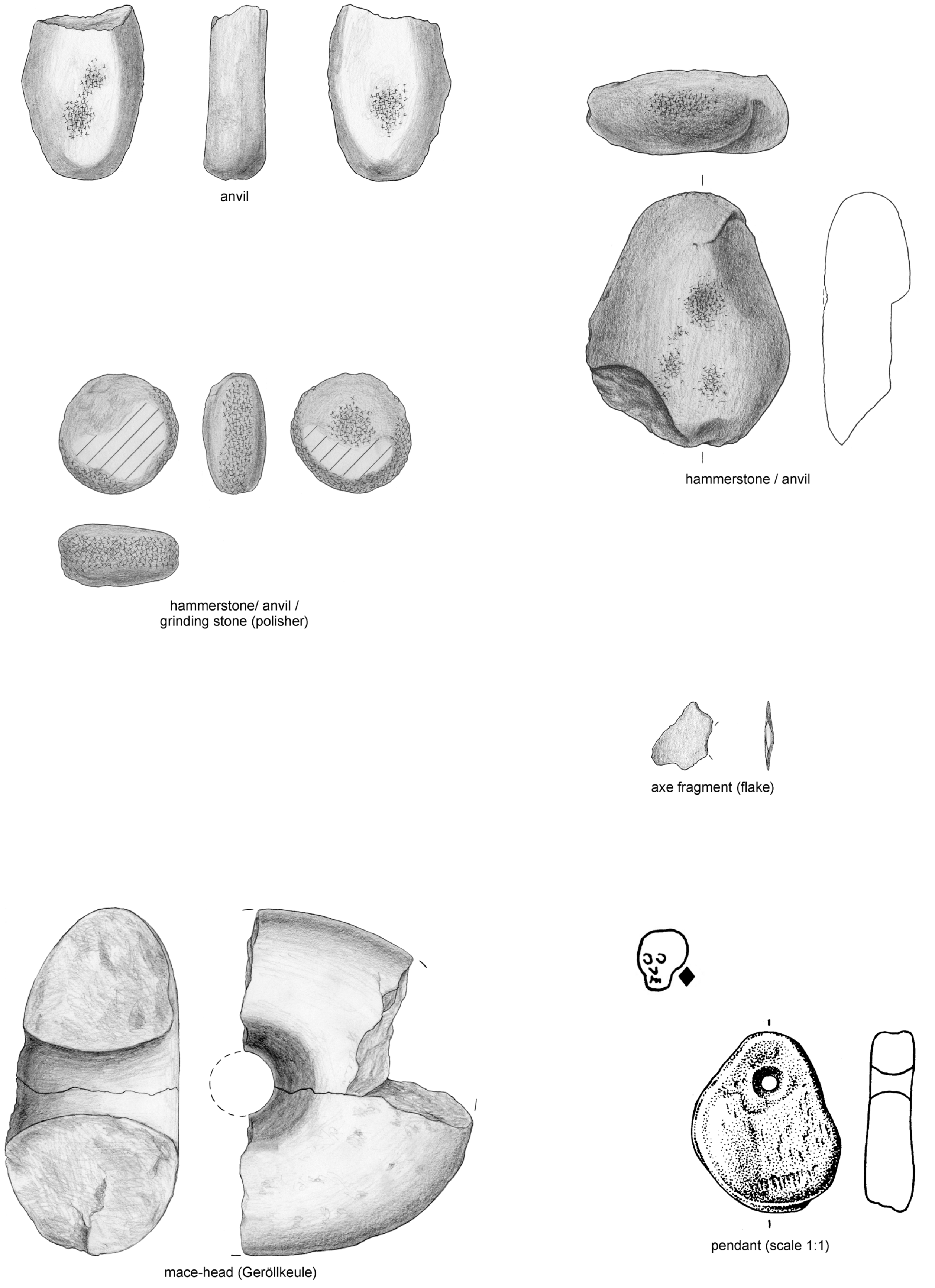


Figure 4.11 Overview of tool types and ornaments present at trenches S21-S24. Scale 1:2 unless stated differently.

so this polish could develop. Their measurements and weight suggests they are only small fragments of what they originally must have been.

Ornaments
The single ornament found on this site, comes from grave I in trench S22, the burial of an isolated skull. With the head of this woman, a jet pendant was recovered. The ornament, measuring 32x27x8 mm, is made out of a tear-shaped flat pebble and still has its original, natural shape. Van der Waals (1976: 619) determined the ornament as a pendant but as it was found 7 cm below the left ear, it may very well have been worn as an ear ornament. Taking into account its measurements and weight, it is possible it was not worn through pierced ears but over the ears like a child would do with cherries, a custom for example practised by the Haida girls of British Columbia, Canada.

Remaining stone material
The three other artefacts are two parts of one mace-head (Geröllkeule), and an unidentified object. The mace-head, the first specimen from the Netherlands to have been securely dated to the Mesolithic (see catalogue section 1.2.5 and Drenth & Niekus 2008: 51, Drenth & Niekus 2010: 754), is produced out of quartzitic sandstone and has an hourglass perforation. The light friction gloss inside the perforation indicates the hafting of the object and may possibly signify its usage. One part was found in a hearth and is burnt; the other part was found c. 20 m away and shows no traces of heat exposure. The refitted artefact currently measures c. 123x83x62 mm and weighs 733.2 g. The estimated weight of the intact specimen would be c. 1500 g.

The third artefact is a conical artefact produced out of gneiss. It is presumably this artefact that was described by Price (1981: 94) as a "pick". I describe the shape as that of a bull's horn and argue that this shape is most likely its natural form. As no marks of manufacturing or even of use are visible, it is my opinion the artefact was not used in any way and should therefore be regarded as a strangely shaped piece of rock.

The waste material is abundant; it largely outnumbers any other find category on the site. Up to 136 indeterminate fragments, 162 cobbles and pebbles, and 30 possible pieces of debitage / tool were recovered. Due to the fourteen different rock types used, the indeterminate fragments display the largest variety of types at the site. The cobbles and pebbles are a collection of oval and flat types, the former being dominantly present (90%). Both types would be excellent blanks for tools and ornaments. The possible debitage materials may be flakes, chips, or fragments therefore but are not characteristic enough to be defined as such.

The smallest fragments of stone, or the grit, are represented by 590 pieces. This is 55% of the total amount of artefacts found at the site. This number is generally low compared to the other Swifterbant sites. The large amount of waste material is possibly also responsible for this low number. This might be the result of the excavation technique, although the material is supposed to have been sieved through 2 or 3 mm meshes, or it might signify a true discrepancy. When the artefacts are weighed individually, it is observed that those weighing 0.1 g occur most often (9%), even if it is only by a little. The other weight classes are represented by very fluctuating numbers producing an irregular graph.

Conclusion
The low number of artefacts < 3 g and the high number of waste material clearly stand out. The debitage material and the tools take second and third place amongst the artefacts ≥ 3 g. There are nearly twice as many flakes as chips, which both largely outnumber the single blade found on the site. The tools are limited in number yet are clearly dominated by hammerstones and anvils as only one polisher and two ground stone fragments were retrieved. Two more find categories were represented by one artefact only, the jet ornament found in grave I and the axe fragment, both from trench S22. The relationship between ornament and grave is again observable on this site.

One of the hardest issues to resolve on this site is the allocation of the stone artefacts to a certain occupation phase. Some artefact types are of a Late Mesolithic date, like the mace-head, while others, the axe fragment for example, are of a Neolithic date. Yet, most artefacts are, typologically speaking, not datable. Comparison with the other river dune sites analysed in this research may shed some light on this issue (see section 4.8.1). The overwhelming dominance of waste material, and the near absence of debitage material and especially tools, may be the result of the site's function. This also applies to the low number of artefacts < 3 g. Besides being a cemetery, the site had a rather limited utilitarian character[9] indicated by the low number of tools, while with the high number of fragments and cobbles it seems to have had a high storage capacity. The site's setting nearest to the Vecht system, the presumed areas of procurement, makes it a prime location as a stone cache or depot.

4.2.6 Site S41

General aspects
There has been no excavation at this site. The few artefacts were exposed during at least one ditch slope inspection.

9 By this I mean the site was not often used for activities which required stone tools such as hide or plant processing, or even food production.

Whether the material was gathered at the ditch side of parcel G39 or of parcel G44 is unknown.

Material

The stone artefacts comprise a flake, a combination tool, and an axe fragment. The flake is made of quartzitic sandstone, is intact, large, and measures up to 79x47x12 mm. The tool is a hammerstone / anvil combination produced on a quartzite cobble with triangular cross section (figure 4.12). Grouped impact traces in the centre of the working surface, and impact traces on one side and the rims, clearly indicates its use. The axe fragment is made of a type of quartzite that is particularly suitable for the production of axes (pers. comm. H. Huisman 2005). It is a fragment broken through the hourglass-perforation that forms a refit with a fragment from site S3 (see catalogue plate 20, figure no. 73).

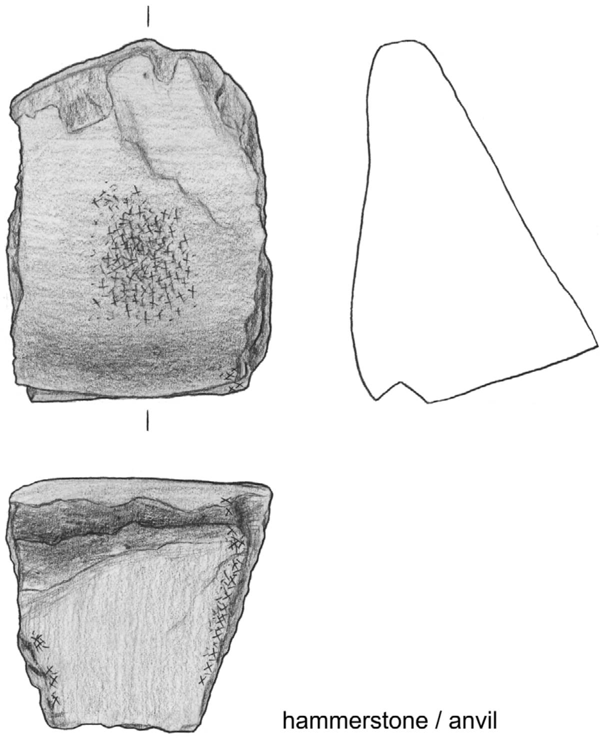


Figure 4.12 Tool present at site S41. Scale 1:2.

4.2.7 Site S51

General aspects

The few artefacts at this site come from one excavation only (1978). The site consists of four peripheral areas with only three remaining core regions. The largest middle area, with the three core regions, is c. 225 m^2 large of which c. 150 m^2 is core region. The trench covers two core regions and a part of the peripheral area. Roughly 120 m^2 is excavated which is c. 53% of the area.

Table 4.5 Total number of artefacts per typological category of site S51.

	Number	%	% ≥ 3 g
Debitage material	**24**	**8.2%**	**47.1%**
Flakes	7	2.4%	
Chips	11	3.8%	
Cores	6	2.1%	
Tools	**10**	**3.4%**	19.6%
Anvil	1	0.3%	
Grinding stones	2	0.7%	
Combination tools	3	1.0%	
Polished axe fragments	1	0.3%	
Ground stone fragments	3	1.0%	
Waste	**17**	**5.8%**	33.3%
Indeterminate fragments	6	2.1%	
Pebbles / cobbles	3	1.0%	
Possible debitage / tool	8	2.7%	
Subtotal ≥ 3 g	***51***	***17.5%***	*100%*
< 3 g	**241**	**82.5%**	
Total	**292**	**100%**	

The stone artefacts form a group of 241 artefacts < 3 g and a group of 51 artefacts ≥ 3 g (table 4.5). With 82.5% the smaller artefacts clearly outnumber the larger ones. The artefacts ≥ 3 g are defined as debitage material (47%), tools (20%), and waste material (33%) and are produced out of ten different rock types. A preference for quartzitic sandstone and granite is observed, while gneiss, porphyry, and quartzite are used less often. Three artefacts are heavily exposed to heat, that is 6% of the artefacts ≥ 3 g.

Debitage material

This artefact category is the largest group within the artefacts ≥ 3 g. It consists of 7 flakes, 11 chips, and 6 cores; no blades were found. The flakes are all intact and have average measurements of 27x33x13 mm. Two flakes are especially wide and thick compared to their length; they reach up to 35x60x19 mm and 39x46x19 mm. Of the chips seven specimens are intact (64%) which have average measurements of 10x11x5 mm. It is noticeable that the chips are exclusively produced out of quartzitic sandstone and granite. This may however be related to the limited number of artefacts. The cores are all tested fragments with one or two flake scars often in combination with two or three impact traces on the surface. No blade removals were observed. Their dimensions show a rather large diversity resulting in an average of 38x46x28 mm.

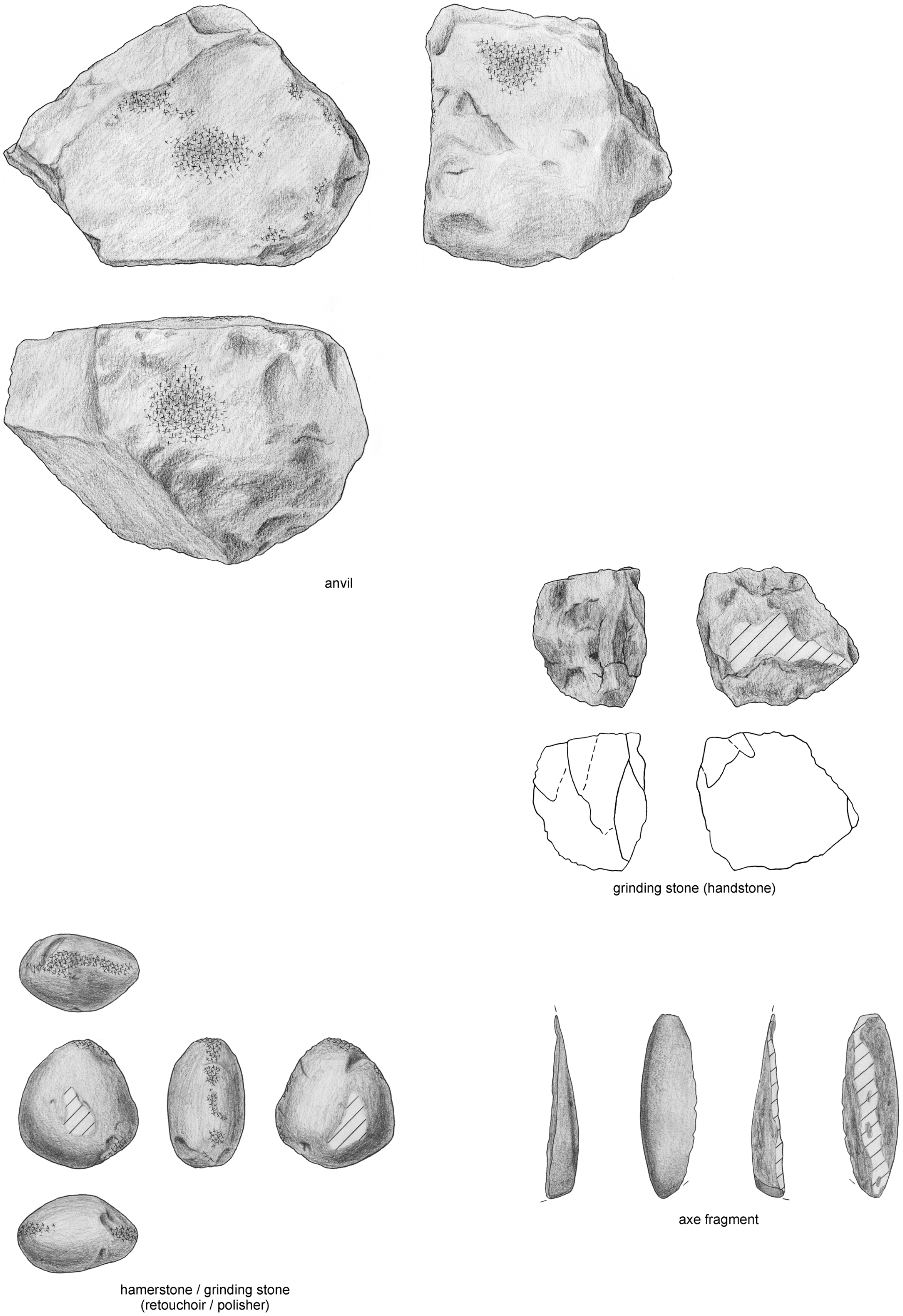


Figure 4.13 Overview of tool types present at site S51. Scale 1:2.

Tools

The small collection of tools are 1 anvil, 2 grinding stones, 3 combination tools, 1 axe fragment, and 3 ground stone fragments (figure 4.13). These tools are produced from a variety of blanks, both in type and in shape.

The anvil is a somewhat irregular shaped piece of granite with several planes of fracture. Two surfaces and one side show grouped impact traces, mainly in the middle of the working surface. On one surface the intensity of the impact traces varies from normal to forceful.

The two grinding stones are probably one grinding stone and a polisher. The first is a re-used core with triangular cross section. The working surface is lightly convex and therefore mainly polished in the centre of the surface. The other tool was made from a pebble and shows at least one surface with a gloss and discolouration as the result of use. The opposing surface might have been used more lightly but the applied lacquer which covers the artefact's number prevents a proper analysis.

The combination tools are two hammerstone / anvils, and one hammerstone / grinding stone (polisher). The first two have two opposing flat surfaces with grouped impact traces in the centre of one working surface. Additional impact traces are visible on the surface, rims, and one extremity. The hammerstone / grinding stone may be defined as a hammerstone / polisher as it is produced on a pebble with triangular shape. Both surfaces are smoothed to polished showing a light gloss; the three extremities and part of the rim also show intense impact traces.

The axe fragment is a flat, elongated oval shaped artefact that may be described as a blade-like object. It presumably detached during use as the plane of fracture starts at the cutting edge and runs along the side of the axe. The surface is polished and the plane of fracture is smoothed to polished as well. Use-wear analysis revealed wear traces on both surface and both ends (see section 4.5). Presumably the artefact was used, at least in some way, both before and after its detachment.

The ground stone fragments are a combination of a flake and two indeterminate fragments with a smoothed to polished surface or area. They have varying measurements and are all produced out of a different type of rock.

Remaining stone material

The waste material combines 6 indeterminate fragments, 3 cobbles and pebbles, and 8 possible pieces of debitage / tool. The number of raw materials used is limited as are the artefacts themselves. The cobbles and pebbles are a mixture of oval and flat pebbles. The possible pieces of debitage / tool may be interpreted as flakes, chips, or fragments therefore, yet they are insufficiently diagnostic to do so convincingly.

The grit, or the 241 artefacts < 3 g, forms the largest part of the artefacts present at the site (82.5%). As only a part of the material was weighed individually, the information content is maybe rather low. Still, the artefacts weighing 0.1 g are most common (49%).

Conclusion

The high number of artefacts < 3 g is noticeable at the site. The artefacts ≥ 3 g are mainly debitage and waste material, although the tools also take up a considerable part. The debitage material is made up of chips, flakes, and cores; not a single blade was retrieved. Seeing the low number of larger artefacts, this total absence might be unrepresentative. Yet, the limited presence of blades has also been observed on many other sites. With the single activity tools the grinding stones outnumber the anvils, yet when the combination tools are added, there seems to be a rather even spread of hammer, anvil, and grinding functions. The remaining artefact is a peculiarly shaped axe fragment. Finally, it is unclear whether the absence of ornaments is related to the absence of a cemetery, or even more, whether the absence of ornaments and a cemetery is related to the eroded character of the site. Equally, the absence of a cemetery may be of no significance at all, since site S3 produced plenty of ornaments and no cemetery either, while a difference is site function might be.

Table 4.6 Total number of artefacts per typological category of site S61.

	Number	%	% ≥ 3 g
Debitage material	**12**	**0.5%**	66.7%
Flakes	2	0.1%	
Flake fragments	1	0.0%	
Chips	6	0.2%	
Cores	3	0.1%	
Tools	**2**	**0.1%**	11.1%
Anvils	1	0.0%	
Combination tools	1	0.0%	
Ornaments	**2**	**0.1%**	11.1%
Waste	**2**	**0.1%**	11.1%
Pebbles / cobbles	1	0.0%	
Possible debitage / tool	1	0.0%	
Subtotal ≥ 3 g	***18***	***0.7%***	*100%*
< 3 g	**2546**	**99.3%**	
Total	**2564**	**100%**	

4.2.8 Site S61

General aspects

The material at site S61 was found during one excavation (1978). The river dune extends over an area of c. 3400 m². The trench covers an area of roughly 60 m² to 75 m², which is only 2% of the whole river dune.

The stone assemblage consists of 2546 artefacts < 3 g and 18 artefacts ≥ 3 g (table 4.6). This means that the smallest artefacts form 99% of the material found at the site. The artefacts ≥ 3 g are separated into debitage material (67%), tools (11%), ornaments (11%), and waste material (11%). The percentages of these categories are not so informative, as the total number of artefacts ≥ 3 g is very limited. Only four rock types were used, mainly different types of quartzite. Amber is only employed for ornaments. Heat exposure was observed on the anvil only (11%).

Debitage material

These artefacts, the largest group of artefacts ≥ 3 g, are a collection of 3 flakes, 6 chips, and 3 cores. Of the three flakes two are intact (67%) and have average measurements of 29x27x13 mm. Yet, the fragmented flake is larger, even in its current state, measuring 53x69x19 mm. Half of the chips are intact (50%), one of them is a very small piece of amber (see below), the remaining two have average measurements of 9x14x7 mm. The cores are three tested fragments. They have only flake removals, ranging from one up to three, and several impact traces on the rims.

Tools

The tools are defined as 1 anvil and 1 anvil / grinding stone combination (figure 4.14). The first is produced on a cobble with triangular cross section. The working surface is characterised by a large, wide pit with grouped and random impact traces. It was observed that the artefact is a re-used anvil possibly grinding stone combination tool. Whether the grinding surface was still used after breakage could not be determined. The second tool has two opposing flat surfaces with different traces. The first working surface is a smooth to polished surface with a shallow but broad pit and grouped impact traces in the middle; the second surface only shows some light impact traces.

Ornaments

The only ornament on the site is the refit of the two bead fragments with the amber chip (see above). Apparently, the triangular bead was broken through the perforation in several pieces and still remains incomplete today.

Remaining stone material

The waste material consists of one pebble and one possible piece of debitage / tool. The vein quartz pebble is very small and the possible piece of debitage / tool may be a flake.

The grit, or the artefacts < 3 g, is by far the largest group of artefacts at the site. As with the artefacts on site S4 and S51, the majority was weighed in bulk. The information from the individually weighed pieces is therefore limited. Still, up to 79% of the pieces weigh 0.1 g. It was observed that the artefacts < 3 g are of the same general rock types as the artefacts ≥ 3 g. Larger white quartz fragments and little quartz grains the size of pin-heads were regularly observed throughout the material < 3 g, sometimes in substantial amounts.

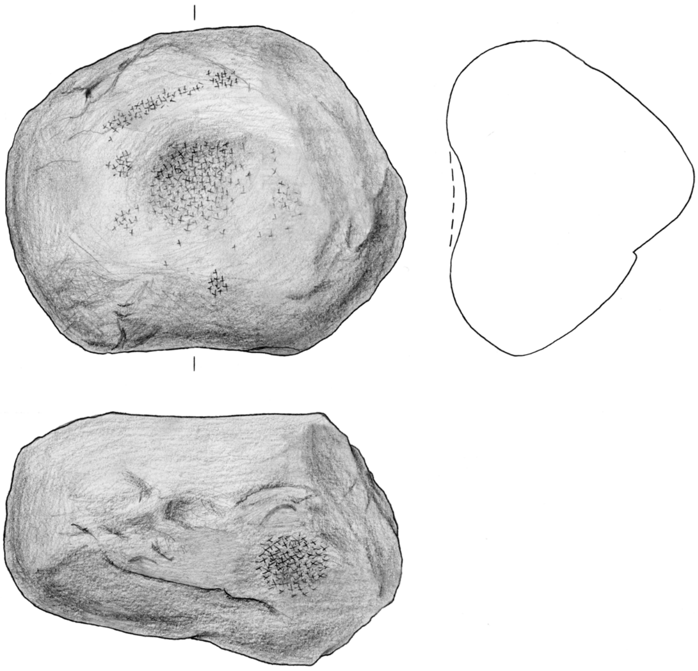
Conclusion

The stone assemblage is clearly dominated by the artefacts < 3 g (99%), very similar in percentage to site S4. The artefacts ≥ 3 g largely consist of debitage material, less of waste material, and only of one or two tools or ornaments. The debitage material mainly consists of chips but seeing the general low number of the artefacts ≥ 3 g it remains uncertain whether this is a real trend. The same applies to the absence of blades. The two tools give evidence of grinding activities at the site and the need of anvils. Noteworthy is especially the absence of hammerstones and ground stone fragments as these occur often on other sites. Again, the very low number of artefacts ≥ 3 g may explain this. The absence of axe fragments is perhaps less surprising as their number is limited on other sites as well. The only ornament was found in the cultural layer, as on site S3 where a cemetery is also lacking.

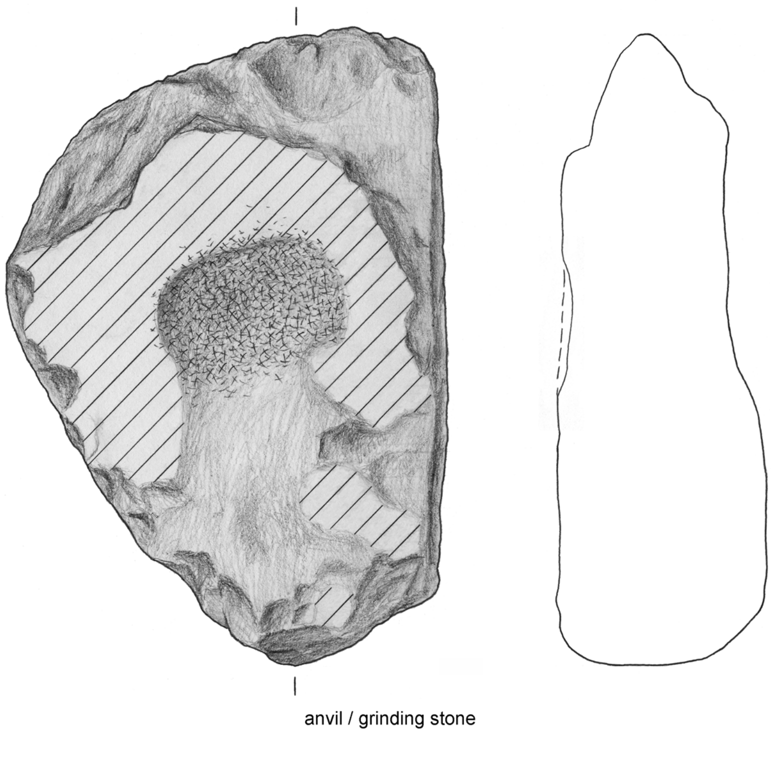
Stone debitage at the site, whether for (flint) tool or temper production, is established by the presence of flakes, chips, and cores. Anvils point to this as well, although they may have served many functions. The grinding stone implies a wider activity range than just tool production, just as the occurrence of white quartz for temper does.

This river dune site shows a combination of Mesolithic and Neolithic habitation phases, just as the other river dunes. The waste layers at the edge of the dune (see section 2.6.15) provide extra information that may lead to the cultural designation of the material. Both de Roever (2004: 29) and Deckers et al. (1980: 142) conclude that the two upper layers are later than the three lower layers. Most of the stone artefacts were found in the upper layers suggesting the mainly Neolithic character of the stone material, if we believe this little sample to be representative of the whole assemblage.

bead (scale 1:1)



anvil



anvil / grinding stone

Figure 4.14 Overview of tool types and ornaments present at site S61. Scale 1:2 unless stated differently.

4.2.9 Sites S80-S84

General aspects
Little research has been done at this site. Several ditch slope inspections (1959 – 1993) and a little excavation (2002) resulted in a handful of stone artefacts.

Material
Of the six stone artefacts present at the site, this study is limited to two; the four other artefacts could not be retrieved and remain unstudied. The two analysed artefacts are artefacts < 3 g, one from site S81, and the other from site S83.

4.3 Raw materials

4.3.1 Introduction
All the stone material had to be brought to the site from certain distant places as no such material naturally occurs in the area around Swifterbant. The identification of these procurement sites is, however, not as self-evident as it would seem at first. The people at Swifterbant must have preferred certain types of stone for certain types of tools or activities. Therefore, the material does not need to reflect exactly the same composition of stone types as is present at the procurement sites. Furthermore, the stone material may have been collected from many different provenance sites spread over a wide area. Although it is possible to define between northern and southern types of stone[10], some types may be found in both areas. Finally, the potential sources for the Swifterbant area are nearly all secondary deposits. Still, the shape, surface, stone type, and type composition may hint at certain sources as some stone types can be considered as guide types.

4.3.2 Stone types and procurement areas

Glacial erratics
Both on the levee sites and the river dune sites the presence of glacial erratics is overwhelming (96.4% and 98.6% correspondingly). Almost all stones retrieved from the excavations can be defined as cobbles and pebbles originating from the boulder clay and boulder sand deposits. The provenance of these stones can be inferred from their composition, shape, and appearance.

Boulder clay or ground moraine deposits are a secondary collection of northern stone types and clay. During the Saalian ice age, massive amounts of clay, sand and stones were transported by glaciers and ice-sheets from Scandinavia to the south. In the Netherlands, the ice-sheet coverage reached as far south as a line drawn between Haarlem (Vogelenzang), Utrecht, and Nijmegen. These deposits are often full of stones that can be enormous boulders of many tons, large cobbles of a few kilos to a few hundred grams, or smaller pebbles of less than hundred grams. These glacial erratics are irregularly dispersed throughout the clay and often have sub-angular to well-rounded forms. The stone types within this clay are directly linked to the districts the ice has travelled over. So by the composition of stones the origin of the boulder clay can be reconstructed (Van der Lijn 1973). Therefore, many Scandinavian rock types may be found in the boulder clay in the Netherlands. In archaeological contexts, this principle is of limited relevance as selective procurement will have taken place in the past.

In the Netherlands the boulder clay deposits outcrop in Gaasterland, Vollenhove, Havelterberg, or in Urk, Schokland, and other outcrops in the Noordoostpolder like Tollebeek and De Voorst (figure 4.15), but also on Wieringen and Texel. Some boulder clay relics can be found on the Utrechtse Heuvelrug and in the Veluwe region (see figure 4.16)[11]. As the outcrops of Urk and Schokland are nearest, approximately 10 and 14 km away from site S3, they are the most likely source for the Swifterbant stones (Deckers 1979: 148). The accessibility of the outcrop areas by canoe along the creek systems must have been an extra impulse to obtain the material from Urk and Schokland. However, this was possibly quite a challenging journey. The two creek systems required to travel from Swifterbant to Urk or Schokland, the palaeo-IJssel and the Vecht, are two separate systems. The only connecting way is by walking the distance where rivers are the nearest or by paddling all the way round to the west where both river systems connect or flow into the sea.

Most of the artefacts from the sites are defined by general raw material types such as granite or porphyry because they have no specific features or are no longer retraceable to their original outcrop areas. Some types are so typical they are also described by sub-type like brown or red East Sea porphyry, Smaland or Dalarne porphyry, biotite gneiss, muscovite schist, palaeo-basalt, or radiolarian rock to name a few.

The cobbles and cobble fragments used as blanks for the tools are in most, if not all, cases stones that are round or have rounded shapes, without sharp or fresh edges. For the tools that are handheld this is especially the case, and it must be stated that they comfortably lie in the hand. The longitudinal dimensions range between 35 mm and

10 In this research both terms will be used to point out the origin of the different rock types. Northern types of stone originate from Scandinavia while Southern types originate from the Ardennes and the Meuse / Rhine area.

11 Another possibility is the beaches where material washes ashore. However, the question remains whether such large cobbles as used on these Swifterbant sites wash ashore as easily as coastal flint does.

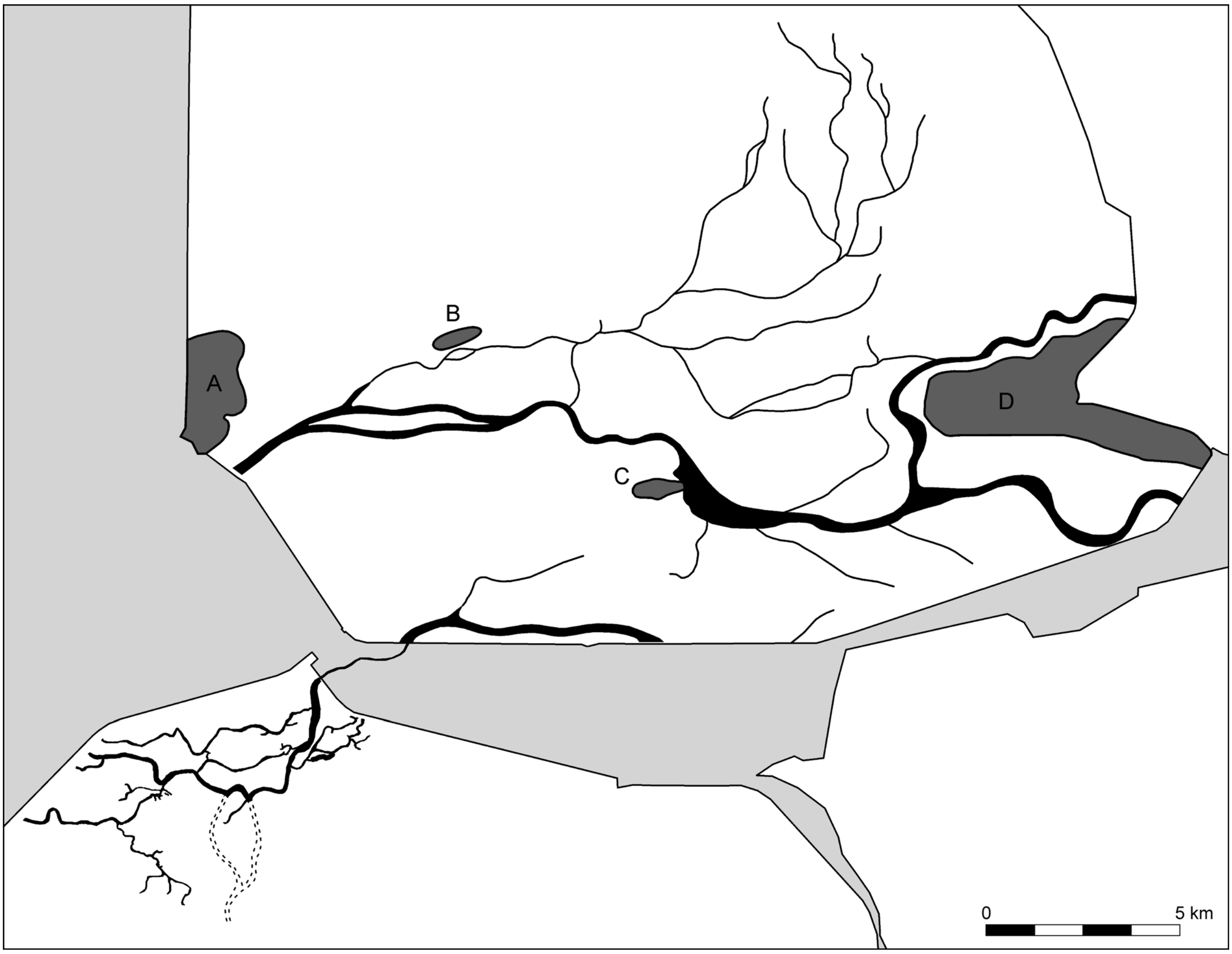


Figure 4.15 Outcrops of boulder clay in the area around Swifterbant (after Ten Anscher & Gehasse 1993): A: outcrop at Urk, B: outcrop at Tollebeek, C: outcrop at Schokland, D: outcrop at De Voorst.

95 mm, their weight between c. 30 g and 300 g (see section 4.8.2). The tools that are produced out of old tool fragments are often smaller and may be more angular due to fracturing.

Thus, the wide variety of raw material types and the abundance of the material make me conclude that the boulder clay deposits are the procurement sites of primary importance for stone material. It is also probable that the outcrops of Urk and Schokland are the most likely source.

Southern material
The presence of material of southern origin on the levee and dune sites is much smaller (3.6 % and 1.4% respectively). This limited set of artefacts consists of specific raw material types in particular shapes. They consist mainly of pebbles and axe fragments. For the first type it seems that sandstone and quartzitic sandstone flat pebbles were preferred. Certain types of these pebbles, for example quartz vein pebbles, do not occur in the boulder clay but originate in the Ardennes (Bosch 1982, 1992) and in the Rhine area. Both of the rivers Rhine and Meuse transported the pebbles up north where they can be found in the middle of the Netherlands (Utrechtse Heuvelrug, Veluwe region, Meuse terrace gravels south of Nijmegen). The second type is a combination of different axe fragments shattered over different sites. Several are made from specific, southern stone types. One axe (S3: no. 49696) and a group of five fragments (S4: no. 1034, S4: no. G92-00488-1, S4: no. G92-01484-1, S4: no. G92-01563-1, S3: no. 57510) are made out of a fine-grained dark grey diabase. This stone type has its origin in the Rhine area, more specifically the region Sauerland or Harz (pers. comm. H. Huisman 2005). The shaft-hole axe fragment (S3: no. 27556, S3: no. 51061) is a fine-grained metamorphic amphibolite, a tough raw material type making it very suitable for the production of axes. This type of raw material was already preferred for the production of adzes in the LBK (Bakels 1987: 62). Van der Waals suggested that the Saale region was the area of provenance[12]. The mountains of the Variscan Basement of

12 This information is taken from a seven minute video for the Dutch television service. It is unclear when this video was made or broadcasted; presumably it was somewhere in the 1970's.

Central Europe, the Carpathians, and Sobótka in Polish Silesia have also been proposed (Arps 1978, Schwarz-Mackensen & Schneider 1983, 1986, Frechen 1965); at least they all argue the origin of the amphibolite is on no account local (Bakels 1987). More recently Endlicher (1995) argued for a source in Bavaria. According to Huisman (pers. comm. 2008) this piece of amphibolite might also be a glacial erratic. The final fragment (S51: no. 1564) is produced from a fine-grained quartzite that is more likely to originate from the Meuse region than from the Rhine region (pers. comm. H. Huisman 2007). Furthermore, the 12 remaining axe fragments are either of northern origin (boulder clay deposits or Scandinavia) or could not be designated to a specific area.

Thus, it seems that a specific type of flat pebbles have been sought in certain areas. The Rhine and Meuse deposits in the middle of the Netherlands must be seen as procurement sites of secondary importance as the flat pebbles gathered there only make up 3% of the material at the Swifterbant sites. The other way round, from these procurement sites only specific stone materials, i.e. certain types of flat pebbles, were gathered. This also applies to several of the axes. These are produced from three different stone types originating from three different southern locations. Although the shaft-hole axe fragment might be of northern origin, a non-glacial erratic origin is more likely as the production sites of these artefacts are located in the Rössen and Bischeim cultural region (De Grooth 2005, Verhart in in prep.). So it is not so much the raw material that connects this artefact to a southern region, it is the straight perforation and the axe type itself that sets it apart from the northern material.

Amber

The amber occurring on the sites is limited to ornamental use only. All artefacts are pendants and beads, or fragments thereof, whereas no natural or unaltered lumps have been excavated. The minimum dimensions of the intact ornaments are 6x5x2 mm and the maximum dimensions are 37x23x19 mm. Weight ranges from less than 0.1 g up to 7.3 g. This results in averages of 14x11x7 mm and 1.1 g.

Amber is a fossil tree resin that, although it is not mineralised, is often defined as stone or even gemstone. Because it used to be a sticky, organic substance amber can contain small insects or plant remains. Most common is the yellow-orange variety, but whitish colours to darker brown or red shades occur as well. Amber can both be transparent and opaque, and all varieties in between such as cloudy (Klebs 1887). It is the presence of numerous microscopic air bubbles that makes the amber opaque and reduces the quality. Generally speaking, the higher the transparency, the greater the hardness and quality of the amber (Savkevič 1970). On the Swifterbant sites almost all ornaments are produced out of translucent amber. A clear exception is the pendant in the child's grave on site S4. It is also possible that this pendant suffered from oxidisation after it was made or even buried. Mazurowski's studies (1978, 1983, 1984) indicate that the selection of good quality amber was a conscious decision. Apparently, the foamy structure of low quality amber interferes with the treatment of the lumps, i.e. perforation (Mazurowski 1984: 20). Although it is soft, between 2 and 2.5 on Mohs' scale (Piena & Drenth 2001: 436), it is brittle and amorphous. Furthermore, the misconception that amber can float on water is commonly held. As its specific weight varies between 1.05 and 1.10 amber is suspended in the water, facilitating transport by moving through it. Its lustrous aspects and its electrostatic properties, which it shares with jet, make amber a desirable raw material for the production of ornaments.

The origin of amber is diverse and geographically dispersed around the world. Besides the well-known occurrence of amber in the Baltic area, like the Samland Peninsula, Jutland or even the coast of Schleswig-Holstein, it also occurs naturally over larger parts of northern Europe like the Balkans and in Northwestern European countries like England and the Netherlands. It even occurs as far south as Switzerland, Austria, and Sicily (Sicilian amber or copal) (Beck et al. 1965, Kars & Boon 1993, Rapp 2009: 116-117). The amber from the Baltic Sea, the Balkans, the east coast of England and the Netherlands is defined as 'Baltic amber' or 'succinite' because of its high concentrations of succinic acid (Beck et al. 1965, Beck 1970). All this amber originates from the same marine glauconitic sand occurring in the Lower Oligocene strata of Samland and is therefore hard to tell apart. Pieces of amber are eroded from the sea floor and transported through the water. Baltic amber also occurs in the boulder clay deposits on the North Sea basin floor and in the brown coal layers (lignite deposits) in the north of the Netherlands and Germany (Huisman 1977). Because of the great depth of the latter, it is considered to be of no archaeological significance. However, Huisman argues that tidal channels of the North Sea may have washed material out of these deposits. Depending on the location of the marine layers and the sea currents, amber will wash ashore in Denmark, the Netherlands or eastern England.

In the Netherlands the most common occurrence of amber is the northern coast where it washes ashore, and to a lesser extent the western coast like Noord-Holland (Brongers & Woltering 1978, Van der Valk 2007, Waterbolk & Waterbolk 1991) (figure 4.16). Amber is also present in the boulder clay outcrops around Urk and Schokland (Van Spronsen 1977; Waterbolk & Waterbolk 1991) where it can wash ashore as well. It has also been found in the Dollard, often in large pieces, the Saalian moraine deposits which cover large areas in the north of the Netherlands, i.e. the boulder clay, or even the

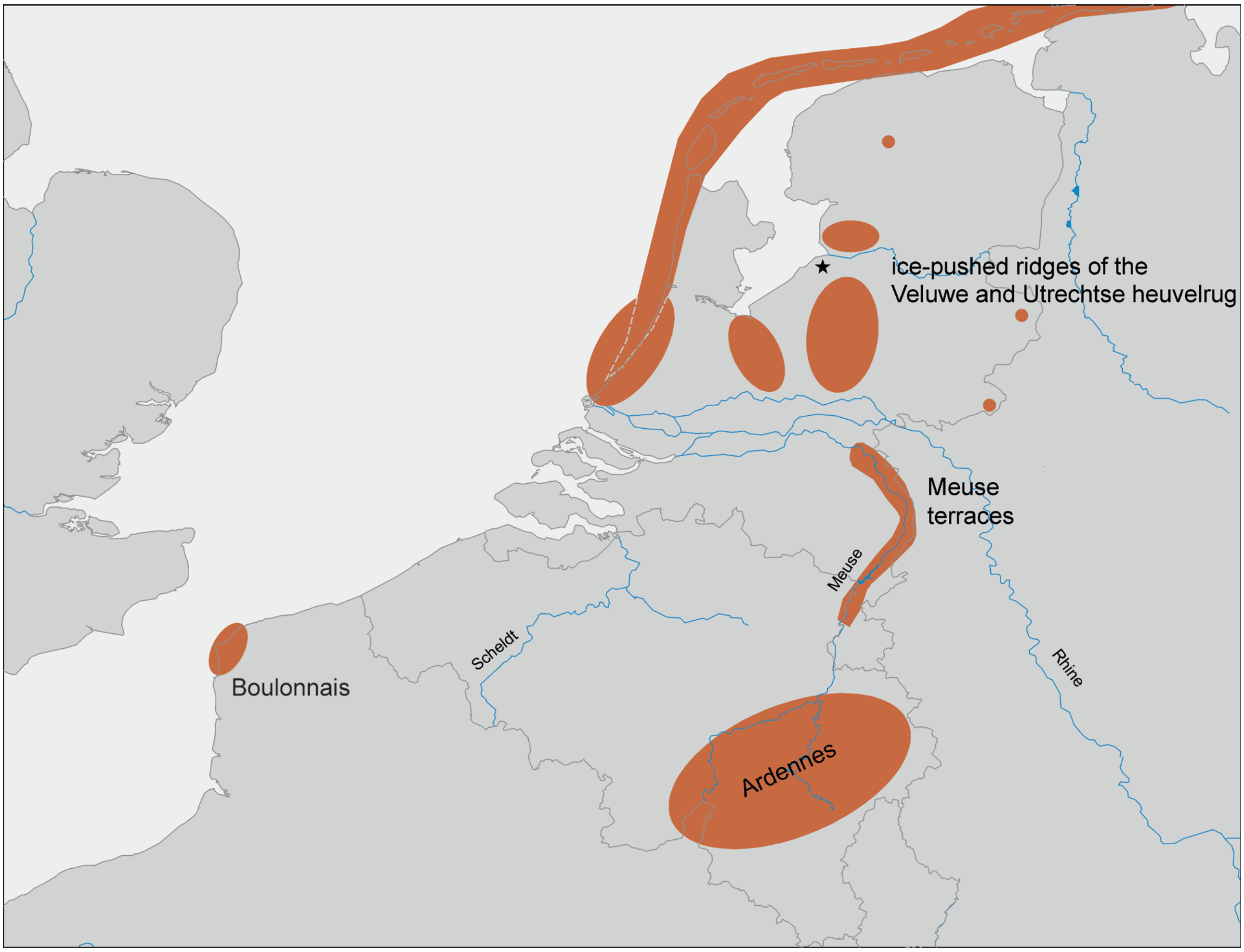


Figure 4.16 Provenance areas of amber, jet, and pyrite. Adapted from van Gijn & Houkes 2006, fig. 8.2.

ice-pushed ridge at Denekamp (Boekschoten & Veenstra 1967, Van Spronsen 1977, Venema 1854, Waterbolk & Waterbolk 1991). This regional occurrence of amber make Brongers and Woltering (1978) believe that in (pre) historic times amber was not imported from the Baltic area but gathered locally. This interpretation of least effort and proximity is followed here.

One of the above mentioned possible places to gather amber is Urk or Schokland. These would be reasonable procurement sites as the majority of the stone material used at Swifterbant is probably gathered there as well. The Wadden Islands and the coast of Noord-Holland may also be prime locations. We must, however, bear in mind that the area of procurement can be but may not always need to be the area of production. Even more, raw material may be transported from the procurement area to a workshop, where it is modified into an object (e.g. a pendant/ornament), and from where it is subsequently transported to other locations or areas, maybe even its end location. Without this intermediate stop-over, i.e. the workshop, the raw material may never have reached this end location.

Jet and oil shale

On all sites only two artefacts of shale (sites S2 and S3) and one artefact of jet (trench S22) have been found. All three are ornaments.

Jet and oil shale are, together with lignite and cannel coal, very similar stone types which are hard to separate visually. Most methods to conclusively distinguish one from the other are destructive tests in which the ratios of carbon and mineral contents are measured. Therefore, archaeologists are forced to rely upon appearance and provenance. Jet is commonly better preserved and is often shiny, whereas shale is generally dull and laminated (Pollard et al. 1981: 140-141). Also, the specific weight of jet is lower than that of shale but as the margin is slight, 1.18 versus 1.28 (Bussel 1976), its practical use in archaeology may be questioned.

Jet is a carboniferous rock that is defined in mineralogical terms as “a hard coal-black variety of lignite usually found in isolated masses in shale and representing coalified fragments of coniferous wood” (Tomkeieff 1954). Both a soft and a hard variety exist. The first is a layered, sedimentary stone type that fractures horizontally along the layers; the second is a metamorphic stone type that fractures conchoidally (Muller 1987). Jet is soft enough to be shaped and is easily polished to a bright gloss (Pollard et al. 1981: 140).

Oil shale, also a carboniferous rock, is "a fine black to brown shale containing sapropelic material (Kerogen) and characterised by having a brown streak, a leathery appearance with parting planes often smooth and polished" (Tomkeieff 1954).

The most famous location of jet is undoubtedly Whitby, England. Today jet still occurs along the east coast of England in the Jurassic Lias deposits near this town in North Yorkshire. Other sources are the Alps of southern Germany, the Normandy coast (Boulonnais), and the brown coal layers in the north of the Netherlands (Huisman 1977, Muller 1987); shale may also be found there (figure 4.16). The low specific weight of jet facilitates transport by water and therefore both England and France, as well as the Netherlands, may be the provenance areas of jet, proven by the secondary procurement sites found in the area around Cambridge, in Kimmeridge Bay, and Skye (Elgee 1930, Van der Waals 1976). However, jet mostly washes ashore in the middle of the Netherlands (van Gijn 2006) whereas Boulogne-sur-Mer as place of origin for imported jet pendants is often quoted in the Dutch literature ever since it was published by Louwe Kooijmans (1985).

Pyrite - Marcasite

Of this rare stone type one fragment was retrieved from site S3 (figure 4.17). Pyrite and marcasite both are iron sulphides of the same chemical composition. Although they have a different crystal structure they both can occur as radial nodules. Even then, their crystal structure sets them apart making them two separate minerals. However, in the radial form, both are very hard to distinguish (Van der Lijn 1973). As the surface of the retrieved artefact is somewhat weathered the distinction between the two is hard to make. Yet, this weathering may suggest that it is marcasite as this is more brittle due to the unstable crystal structure (pers. comm. H. Huisman 2005). On the other hand, radial pyrite has been known from other sites in the Netherlands. In literature, the choice is often made not to distinguish between the two and refer to the raw material as radial pyrite (Beuker 2008, van Gijn & Houkes 2006).

One of the primary sources of pyrite is the Ardennes (250 km) which does however not need to imply import from that area as the clay outcrops near Denekamp and Winterswijk (100 km) are also a possible source (Van der Lijn 1973), just as Drachten (Schuddebeurs 1958). Pyrite has also been found in southern Limburg, in the Meuse beds and along the brooks of northern Brabant (Van der Lijn 1973, van Gijn 2006).

Marcasite can be formed as a primary or a secondary mineral. As a primary mineral it forms nodules in sedimentary rocks, such as limestone, shale or lignite. As a secondary mineral it forms by chemical alteration of a primary mineral such as pyrrhotite or chalcopyrite. Marcasite, and also pyrite may be found in chalk deposits, like the White Cliffs of Dover in England or the chalk deposits in the Boulonnais region in France (Cap Blanc-Nez, Boulogne-sur-Mer) (330 km). Small nodules of marcasite can also be found in moraine deposits (Stapert & Johansen 1999, Van der Lijn 1973).

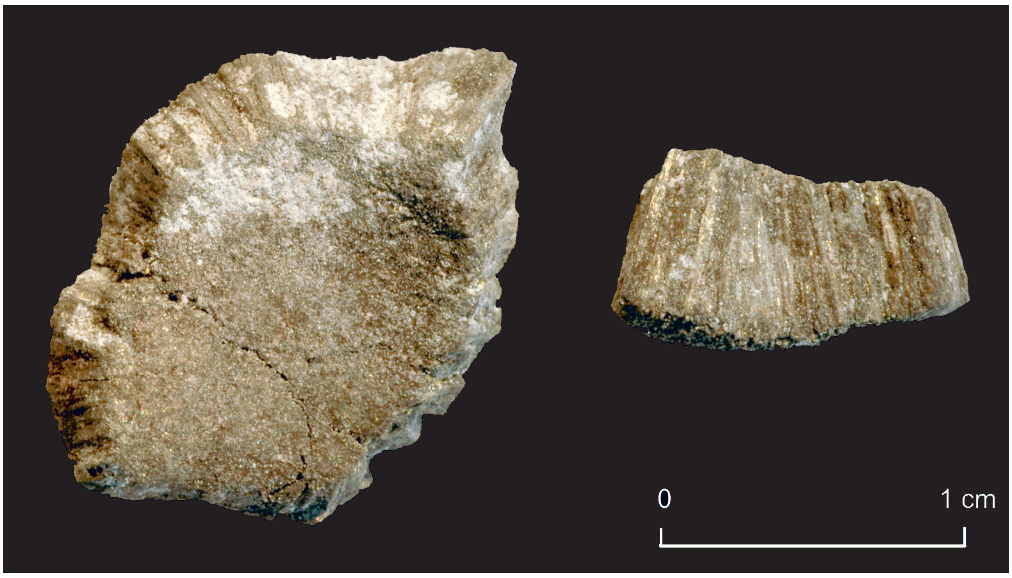


Figure 4.17 Fragment of radial pyrite found at site S3. Taken from Woltinge et al. 2008, fig. 1.

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4.3.3 Interpretation and conclusion

The composition of northern versus southern stone types from all the sites is roughly the same. The overwhelming presence of boulder clay erratics suppresses the southern erratics to a minimum. Therefore it may be concluded that the boulder clay deposits are the primary source of stone material. Southern stone types are so limited in number the south cannot be rightfully interpreted as a secondary source. However, the nature of these stones, being mostly (flat) pebbles chosen for a specific propose, suggest a well-considered selection of these materials. Additionally, a few non-local types are to be included as well such as amber, jet, shale, and radial pyrite.

Rich boulder clay outcrops can be found 10 to 14 km from the sites at Swifterbant (Urk and Schokland). As the boulder clay is the primary source a good quality procurement site with sufficient variety, quantity and quality of stones may be preferred in an area with easy access (site territory, see section 4.8.4). The southern material may have been gathered at the Veluwe or the Utrechtse Heuvelrug, areas where some erratics can be found as well. These areas are located between 30 km and 40 km from Swifterbant[13] (year territory, see section 4.8.4). The few non-local raw material types may have been gathered at farther locations; pyrite / marcasite, jet and shale as far as 330 km or as close as 100 km. The same accounts for amber which may have been gathered at the northern or western coast of the Netherlands, at 100 km or 70 km from the site respectively, or inland also at 100 km. The amber ornaments may also have been obtained by exchange as they consist of finished products only. Finally the axe fragments of which the specimens with a straight or light conical perforation come from the farming communities (Rössen? Bischeim? Michelsberg?) some 150 km to the south (sphere of influence, see section 4.8.4).

In the absence of thin sections and the systematic research into sources, it is difficult to conclude, in detail and with certainty, where exactly certain stone types were procured. Therefore, the above interpretation is limited to different spheres of influence or reach and not defined by exact distances.

13 The Veluwe lies approximately between 30 and 70 km from site S3, whereas the Utrechtse Heuvelrug is situated between 40 and 70 km from site S3.

4.4 Refitting

4.4.1 Introduction

The refitting of stone artefacts is more difficult than that of flint[14] because of the coarseness and weathering of the raw material. Therefore certain fine-grained or compact and cemented types of raw material are a more suitable choice when a refit analysis is conducted. The analysis here focuses on quartzitic sandstone[15]. With quartz and quartzite occurring in too limited quantities to be useful candidates for refitting analysis, quartzitic sandstone is a well-considered choice.

During the course of this Ph.D. more observations concerning raw material types have been made. Sometimes certain artefacts were clearly made from exactly the same type of raw material as certain other artefacts although the artefacts themselves could not be refitted. In that case, they were defined as part of the same raw material unit (RMU).

4.4.2 Intra-site refitting

Site S3

The quartzitic sandstone refits are a collection and often a combination of many different artefact types. The refitting of artefacts may, in some cases, lead to a different definition of the artefact. For example, a flat grinding stone fragment may actually be the distal part of a polished flake but because of the missing proximal - medial part the artefact could not be defined as flake fragment. This, however, does not occur often.

Of the 841 artefacts of quartzitic sandstone available on site S3, a total of 507 artefacts were chosen for this refit analysis. The selection was mainly based on the presence of coordinates. Certain types of artefacts, such as intact pebbles and cobbles, were excluded. This resulted in 16

14 In contrast to the stone artefacts, no systematic research into the refitting of flint artefacts was performed. The fifty refits found at the different sites are the result of observation during the typological analysis of the assemblage. A handful of artefacts from different RMU's have also been observed. Most refits are fitting fragments found in proximity to each other, like a proximal and medial part of a flake, or a potlid from a blade, or sometimes several indeterminate fragments fitting together. Their proximity is suggested by the find numbers that are often sequential or closely related. A refit between an artefact from trench S6 and site S6 was made as well. Some refits are, however, not a simple joining of two fragments of a single artefact, they form a sequential refit. Examples of these are the two blades from site S4 (see catalogue plate 34, figure no. I), and the flake detached from a core from a polished flint axe at site S2 (see catalogue plate 26, figure no. 244).

15 As this study was a pilot study, the material was limited to that of site S3. The incorporation of quartzitic sandstone artefacts from the other sites would have been desirable and preferable, yet did not fit into the time invested for a Masters project. The analysis was conducted by Bettine van Klinken under my supervision.

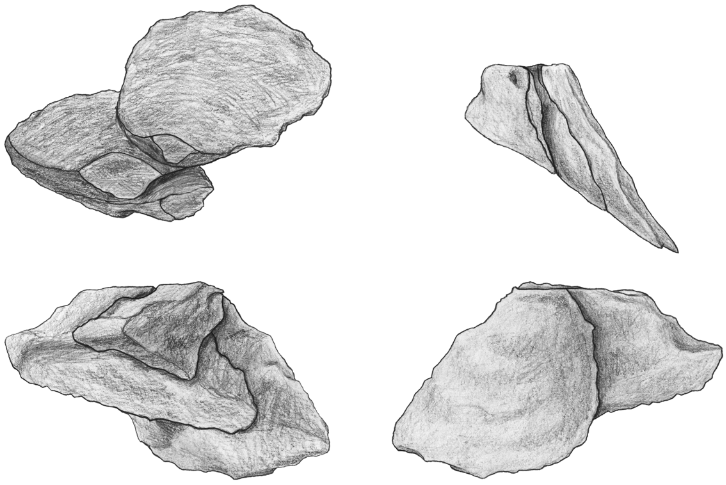

Figure 4.18 Three sequential flakes from site S3. Scale 1:2.

refits of 37 pieces of quartzitic sandstone. An additional 62 fragments could be designated to specific quartzitic sandstone raw material units (RMU).

The refits are mainly fragments of flakes, tools, cores, or indeterminate fragments that fit together. Refit 1 is exceptional as it is three flakes forming one sequence of overlying detachments (nos. 16202, 22068, 23006, figure 4.18). This is the only sequential chain of stone flakes found at the Swifterbant sites. Other refits of flakes or blades are the result of fracturing. Refit 2 is the combination of three flake fragments fitting together that were collected at the same find location (no. 09366-1 + 09366-2 + 09366-3). Refit 3 and 4 are two refitted flakes fractured without an impact point being visible (no. 35641 + 35777, no. 29093 + 45188). Refit 5 is a fractured retouched blade (no. 49914 + 50074).

Refit 6 are two tested core fragments that could be refitted in the same way as the flakes, thus along a fracture made by an impact point; the bulb formed proof of debitage (*no. 22682 + 23162*). Two more impact points and bulbs are visible on other fractured rims of the refit; it is obviously still incomplete. Furthermore, the artefact itself might be a flake as it is rather thin. Another group of three tested core fragments match together showing impact points and bulbs (refit 7: *no. 01664 + 31420 + 35054*). Some isolated impact traces and flake scars give evidence of more pounding or debitage attempts.

Three more refits, refits 8 to 10, are flakes that broke, presumably during debitage, along a latent fracture made by an impact point on the dorsal surface. Refit 8 is a proximal – medial flake fragment (*no. 25310*) fitting to a hammerstone / grinding stone fragment (*no. 18814*). The flake removed a part of the surface of the tool of which only certain areas are smoothed to polished. Around the rim, the flake is covered with impact points. One of these must have been so intense that the flake detached or the flake was detached deliberately along this point. As said, the flake broke along a latent fracture made by an impact point on the dorsal surface, which is the original working surface of the tool. Refit 9 is a proximal polished flake fragment (*no. 20136*) fitting a medial - distal polished flake fragment (*no. 12683*). The flake thus removed a part of the surface of a grinding stone. The same applies to refit 10 (*no. Z-306-1 + Z-306-2*).

Refit 11 is a very large flake of a grinding stone. It might have been fractured along a latent fracture made by an impact point, which is visible, but because of the absence of a bulb this is uncertain (*no. 15486 + 20093*). After refitting, the flake fragment and the grinding stone fragment appeared to be one large flake. Parts of it are still missing preventing the definition of the shallow pit in the former middle of the tool as an anvil pit or roughening patch. The refit of an indeterminate fragment with a grinding stone fragment occurred twice (refit 12: *no. 31590 + 35742,* refit 13: *no. 35326 + 35486*). Furthermore, the two refitted fragments may even be part of the same grinding stone as the grey fine- to medium-grained quartzitic sandstone appears identical. These fragments did not break along an impact point but heat exposure might be the reason for fragmentation. Therefore, this might be one of the few artefacts in this research that might be defined as a cooking stone.

Refit 14 are two potlids fitting together (*no. 35301 + 43312*). They may possibly be a flake fragment but it is not intact and in the absence of a bulb this is just an impression. The same applies for refit 15 (*no. 37947-1 + 37947-2*). Even after the refitting of an artefact < 3 g and a possible piece of debitage, the artefact cannot with certainty be defined as a flake. Finally, all types of fractures are combined in refit 16 (*no. 30782 + 31900 + 31985 + 32177*). This brings a flake, two indeterminate fragments, and a tested core fragment together into a cobble. Approximately a quarter of the artefact is still missing. Limited traces of burning indicate the cause of fracturing, as well as impact points and flaking.

Some of the remaining quartzitic sandstone artefacts could be grouped into 5 different RMUs. RMU 1 is a combination of 25 artefacts made out of the same white, medium-grained quartzitic sandstone. Up to 9 more artefacts may belong to this group as well. RMU 2 is very comparable to RMU 1, a medium-grained white quartzitic sandstone, but with pinkish quartz grains. The three artefacts from RMU 3 have a greyish-white colour and are medium-grained. One of the artefacts is slightly finer grained, yet falls within the variation possible inside one cobble. RMU 4, consisting of two artefacts, is a medium-grained light-grey quartzitic sandstone with a pinkish tint but less pink than RMU 2. Finally RMU 5, a collection of 21 artefacts is characterised by the purple-grey colour of the quartzitic sandstone.

Refits between other types of raw material have been encountered as well. Refit 17 and 18 are both two flake fragments fitting together. The first is made out of granite (no. 04567 + 05421), the second out of quartzite (no. 25509-1 + 25509-2). Another group of quartzite artefacts is refit 19, a group of three fragments apparently forming a blade (no. 911190 + 912493 + 912709). Four more chips may belong to the same core or cobble, making it a raw material unit of seven pieces. Three more refits are a combination of two indeterminate fragments of quartz (refit 20: no. 17467 + 17651), of gabbro (refit 21: no. 22305 + 22653), and of granite (refit 22: 52754-1 + 52754-2). Refit 23 may be, just as refits 2, 10, 15, 18, and 22, a recent fracture as the two artefacts were found at exactly the same coordinates (no. 37234-1 + 37234-2). The final refit at site S3 is a sandstone pebble broken horizontally (refit 24: no. 800267 + 800308).

Some refits have already been discussed. These are the two halves of the shaft-hole axe (refit 25: *no. 27556 + 51061*), the upper and lower part of a grinding stone (refit 26: *no. 37362 + 37526*), and the refitted amber pendant (refit 27: *no. 17359 + 36699*) (see section 4.2.3, and catalogue section 1.2.3). The grinding stone is made of leptite, a very rare raw material type at Swifterbant. Ten more leptite artefacts have been found at site S3, and three more at site S4 (see below).

RMUs are not only observed for quartzitic sandstone, other types of raw material may be grouped as well. RMU 6 comprises three pieces of debitage that must have been detached from the same brown quartzite core with inclusions. RMU 7 is the combination of 18 pieces of red granite (feldspar). This is a rather rare type of granite at the Swifterbant sites, although sought after as temper for the pottery. It is therefore hard to establish whether the additional 47 pieces of red granite (feldspar) come from the same large cobble or from several different cobbles with similar composition.

Other sites

Refits have also been observed at other sites. For site S2 there are 5 refits and three different RMUs. Refit 1 is the combination of a tested core fragment and two flakes out of helleflint (no. 6164 + 6322 + 6615). Refit 2 is a ground stone fragment, a chip and an artefact < 3 g made out of gneiss (no. 6843 + 6844 + 7564). The ground stone fragment shows only light use-wear traces and is made from exactly the same type of raw material as the inter-site refit 2. Because of its flat shape and light traces this may be the lower part of the grinding stone. Refit 3 is also part of a grinding stone, this time out of quartzitic sandstone (no. 7585 + 7728). The fourth refit has already been discussed. It is the two amber bead fragments fitting together found in the cultural layer (no. 901270-1 + 901270-3) (see section 4.2.2, and catalogue section 1.2.2). The final refit comes from the material gathered during the ditch slope inspection. Four fragments of granite-gneiss nicely fit together whereas 7 more fragments make this group into a RMU of 11 artefacts. Other RMUs also come from these finds bags. These concern two different groups of gneiss, RMU 1 and RMU 2, and one group of granite artefacts, RMU 3.

Site S4 is characterised by four refits and two RMUs. Refit 1 is the combination of two fitting pieces of leptite and an additional piece (no. G92-04336-1 + G92-04336-2 + G92-04336-3). As only 15 pieces of leptite have been found at all Swifterbant sites, and these are spread over site S3 and S4 only, there is a large possibility that these three fragments also belong to the same RMU as the grinding stone of refit 26 at site S3 (see above). Refit 2 are three pieces of granite forming a flake (no. 1209 + 1212 + 1239-1). Refit 3 and refit 4 have already been discussed (see section 4.2.2. and catalogue section 1.2.4). Refit 3 are the two diabase axe fragments from the old and the new excavations (no. 1034 + G92-01563-1), in combination with three pieces of the exact same material, including a fragment from site S3. Refit 4 are four fitting pieces of amphibolite and an additional piece of what possibly may have been a perforated axe (no. G92-05505-1 to G92-05505-5). Finally the two RMUs are a group of 12 pieces of gneiss and a group of two pieces also of gneiss but with a different appearance.

Other sites yielding already discussed refits are the mace-head from trench S22 (no. 326 + *10), the fractured cobble from trench S23 (no. 0307 + 0545) (see section 4.2.5 and catalogue section 1.2.5), and the amber ornament from site S61 (no. 900636 + *01 + *02) (see section 4.2.8 and catalogue section 1.2.9)

4.4.3 Inter-site refitting

The most spectacular refit is the combination of a grinding stone fragment (gneiss) from site S3 with a ground stone fragment from site S2. The fragment from site S3 is significantly larger than that of site S2 and was presumably still usable, even after its fragmentation. The two sites are approximately 500 m apart, separated by a large part of the main creek. The question remains how much of the fragments of gneiss may be part of this fragmented grinding stone. The question of whether the artefact originally belonged to site S2 or site S3 cannot be answered satisfactorily, not even if the other fragments of the same RMU are mapped. Of that specific type of gneiss three more fragments were observed within the assemblage from site S2, including refit 2, whereas six fragments were counted at site S3. Even at site S51 a fragment of hornblende gneiss was found in the form of a hammerstone / anvil combination.

Two other inter-site refits have already been discussed; these are the combination of two axe fragments from one side of the small creek (site S3) to the other side (site S41). These two sites are located approximately 200 m apart. As said above, an axe fragment of site S3 is made from exactly the same raw material as the axe fragments and refit at site S4. These two sites are approximately 100 m apart.

Finally, the alleged refit of the leptite fragments. These are spread over sites S3 and S4. The only true refits were found within the separate sites themselves, although it is presumed very probable that they all belonged to the same cobble or even to the same tool.

4.4.4 Conclusion

This research demonstrates that a refit analysis of stone artefacts is possible and fruitful if specific, i.e. non-weathering stone types are chosen. Fine-grained or compact and cemented raw material types are highly useful and give good results. Additionally, the material needs to be well preserved and have a fresh appearance so the planes of fracture have not yet weathered.

The analysis clearly indicates the presence of debitage and/or the deliberate fracturing of tools. It also makes clear that during debitage flakes, or other artefacts, may break just as easily, or even more easily as artefacts out of flint do. Most refits are limited in distance and stay within the boundaries of one site area. A few of them, however, cross these boundaries and end up at the other side of the creek or even farther away.

Inter-site refits may suggest contemporaneity. However, some remarks must be made. Even though inter-site refits are made, their number is limited and there is no way of knowing, except with a full scale refit project, how these few refits represent the magnitude of this phenomenon.

The current state of affairs, with a refit of two axes (between site S3 and S4 and between site S3 and S41) and a grinding stone (between site S2 and S3) may largely suggest isolated events and not a systematic transport of material. Axes are a high valued item, because of their often exotic raw material, their representation of time investment, and possible status or even symbolic values. Their transport as the result of an isolated event is easily explained. The refit of the grinding stone may suggest a more systematic transfer of material. Although they are highly utilitarian objects, which can be said for the stone axes at Swifterbant as well, it has been argued that they must have had a special meaning proven by the their high fragmentation rate (see section 4.8.2). Again, this value may make them appraised and thus worthy of taking them along from one site to the other.

These inter-site refits also indicate contacts between the different levees and by extension the river dunes. It is the time resolution that is the issue here. The different levee sites were inhabited in roughly the same time span of a few hundred years (c. 4350-3950 cal BC). It has been argued that occupation was present for extended periods of time, in all four seasons, yet presumably not year round (Zeiler 1997). The question remains whether occupation occurred each year, every few years, and if there were periods of extended times of absence. The latter is indicated by the band of clay between two parts of the cultural layer at site S2 and between the hoe-field and the occupation layer at site S4. But the time resolution of occupation each year or every few years can currently not be detected by archaeological means. As the stratigraphy at site S3 indicates, the presence or absence of a stable environment may even have influence on the thickness of the layers and thus the visibility of these intervals. The inter-site refits at least indicate a level of contemporaneity which is discernible by archaeology, thus more or less a 'relative' contemporaneity.

4.5 Use-wear analysis

4.5.1 Introduction

If stone artefact analysis has hardly been studied in the past, then use-wear analysis on these stone types was non-existent. Yet, stone objects hold a mass of valuable information on daily activities, mobility, exchange and subsistence. Therefore, both low and high power use-wear analysis should be performed as an intrinsic part of the general study of stone artefacts. It is true that due to the coarser grain size of these stone types the same amount of information cannot be provided as, for example, flint artefacts. Furthermore, some activities, such as hammering, pecking or roughening, lead to the destruction of use-wear traces. Still, the somewhat restricted information content of stone artefacts, in comparison to flint artefacts, should not stop researchers from analysing this artefact category. Once this type of analysis has become current it will naturally develop into an even more specialised field of research that eventually may yield as much information as flint analysis does now and that will be highly valued.

Table 4.7 Number of artefacts analysed in the two use-wear analyses.

	Site S2	Site S3	Site S4	Site S51
Grinding stone	1	3	1	
Hammerstone / Grinding stone	1	5		
Anvil / Grinding stone		2	1	
Hammerstone / Anvil / Grinding stone			1	
Pendant			1	
Axe fragment		1		1
Total	2	11	4	1

During the four years that the material from the Swifterbant sites was being studied, two use-wear studies on stone artefacts were performed. The analyses were all conducted by the Laboratory of Artefact Studies (Leiden University) under supervision of Annelou van Gijn. Her team analysing the stone tools consists of Channah Nieuwenhuis, Annemieke Verbaas and Karsten Wentink. Three separate studies were conducted, mainly focussing on different tools and aspects. The first study in November 2006 (Nieuwenhuis et al. 2006) focussed on grinding stones and analysed eleven tools. The use-wear analysis was conducted by Annemieke Verbaas while Channah Nieuwenhuis performed the residue analysis (see section 4.6). The second study in September 2007 (van Gijn et al. 2007) focussed on four more grinding stones, of which the analysis was performed by the same two researchers, and on two polished stone axes; the latter were analysed by Annelou van Gijn, Karsten Wentink and Annemieke Verbaas. Additionally, a day of intensive use-wear analysis was organised in March 2009 to re-analyse and discuss the matter of the rounding of flint working edges and tips (see section 3.2.5). During this day, one amber pendant and an unfinished pendant on a flint pebble were analysed by Annelou van Gijn and Wouter Verschoof (table 4.7).

The material will be discussed by artefact type regardless of whether it was analysed in the first use-wear study or the second. The reason for this is the similar methodology applied in both studies and the related research questions. The second study may have produced a more detailed data set as the use-wear specialists gained new insights and increased their background information on the material as a result of the first study. Yet, basically the two studies are the same.

4.5.2 Grinding stones

The central research question in this section is whether local arable farming on the levee and river dune sites at Swifterbant was present or not. When the two use-wear studies were conducted, the hoe-field on site S4 had not yet been discovered. Therefore, at that time, a multidisciplinary approach, of all research aspects and auxiliary sciences, was called upon to help answer that central research question. The hope existed that the information would be like the pieces of a puzzle, all fitting together with that one piece that would make the picture complete. Even though this central question has now been answered, the use-wear analysis of these artefacts is of significant value because it provides not only insight into the spectrum of performed activities but also into other research questions, more than that of arable farming alone.

As a general comment A. Verbaas (Nieuwenhuis et al. 2006, van Gijn et al. 2007) writes that the use-wear traces are in the main well preserved and not affected by post-depositional processes. Furthermore she states that impact traces cannot be related to contact material as the traces are removed by the hammering. Yet, in my opinion force of impact may be derived from the magnitude of the impact traces. Also the nature of the contact material, i.e. the hardness and compactness of different types of stone or organic material, must have an influence. However, in the absence of systematic research on this subject, this cannot be quantified.

The selection of tools was based on the presence of macroscopically visual smoothing of the surfaces. Artefacts were chosen from different sites and were of different sizes and shapes (table 4.7). The presence of use-wear traces was established microscopically. These use traces are the result of processing different materials, such as cereals or grasses / siliceous plants. Contact with these different materials result in different traces of use, such as gloss and / or striations.

Site S2

The two artefacts analysed from this site are a grinding stone and a hammerstone / grinding stone combination, both with two opposing flat surfaces. The first tool, a handstone, has one surface that is clearly smoothed showing small areas of light gloss which are visible to the naked eye (no. 1602, see catalogue no. 6, pl. 1, quartzitic sandstone). On the higher parts of this surface moderate to strongly developed traces of contact with cereal or grasses

/ siliceous plants are microscopically visible. They have a clear orientation in the longitudinal direction of the artefact. The opposing surface is also smoothed but with only a lightly developed gloss that is presumably the result of processing cereal or grasses as well. The second tool has a moderately developed gloss of contact with cereal or grasses / siliceous plants on one surface (no. 0001 – 0016, see catalogue no. 7, pl. 2, granite). The other surface shows the same traces of use, even if they are only lightly developed. Still, this surface is used more intensely as more grains of rock have been clearly abraded resulting in the tool being locally bevelled off.

Site S3

The abundance of tools on site S3 facilitated a wide selection from a large variety of tool types. The ten tools can be defined as two handstones from a grinding tool, one with two opposing flat surfaces and one with a triangular cross section. The third is a netherstone and the fourth a hammerstone / polisher combination. Two more hammerstone / grinding stone combinations were selected, one with two opposing flat surfaces and one with a triangular cross section. And finally two anvil / grinding stone combinations and two hammerstone / anvil / grinding stone combinations, all with two opposing flat surfaces, were chosen as well.

The first grinding stone has two opposing surfaces with moderately developed traces of processing cereal or grasses / siliceous plants on the smoothed areas (*no. 11563*, see catalogue no. 46, pl. 9, gabbro). A clear directionality in the traces could be discerned along the longitudinal axis of the tool. The second handstone has a triangular cross section (*no. 50510*, see catalogue no. 47, pl. 9, basalt). The flat surface shows, on the smoothed parts, some light gloss as a result of contact with cereal or grasses. No traces of use were detected on the rough parts of that surface. The smooth areas on the upper surface of the third tool show moderately to strongly developed traces of contact with cereal or grasses / siliceous plants (*nos. 20770 + 7613*, see catalogue no. 49, pl. 10, gneiss). The hammerstone / polisher combination, which is produced on a pebble, bears a moderately developed gloss (*no. 46624*, see catalogue no. 63, pl. 15, quartzitic sandstone). Unfortunately, the contact material could not be defined. The fifth tool is a hammerstone / grinding stone combination with two opposing surfaces (*no. 900141*, see catalogue no. 64, pl. 15, quartzitic sandstone). One surface has two clearly smoothed areas with strongly developed traces of contact with cereal or grasses / siliceous plants. On the area around these patches, the gloss is only lightly developed. The triangular anvil / grinding stone combination has a clearly smoothed surface (*no. *00003*, see catalogue no. 62, pl. 14, granite-gneiss). In some places this surface shows small spots of gloss as the result of contact presumably with cereal grains or grasses. This gloss cannot be clearly defined as the artefact is not intensively used. The first of the anvil / grinding combination tools also has small patches of moderately to strongly developed traces of processing cereal or grasses on its smoothed surface (*no. 26403*, see catalogue no. 59, pl. 13, quartzitic sandstone). On the opposing surface clear areas of gloss are visible. This feature of different intensities of traces on two opposing surfaces was also observed at Geleen-Janskamperveld (Verbaas 2005). The second tool shows a well-developed gloss that is more pronounced at the edges (*no. 28135*, see catalogue no. 60, pl. 13, quartzitic sandstone). Again the gloss is the result of contact with cereal or grasses / siliceous plants. Finally, the hammerstone / anvil / grinding stone combinations are discussed. The upper surface of the first specimen is clearly smoothed by use (*no. 02017*, see catalogue no. 65, pl. 15, quartzitic sandstone). This smooth area shows traces of processing cereal or siliceous plant material. As the traces are lightly developed, the tool was presumably not intensely used. This is confirmed by the lack of use traces on the lower surface of the tool. The impact traces visible in the centre of the surface were applied after the smoothing because they lack any form of smoothing or gloss. The second tool has only one surface with smoothing (*no. *00001*, see catalogue no. 66, pl. 16, quartzitic sandstone). The impact traces on this surface are rather fresh as with the previous tool. The artefact was presumably not used over an extended period of time as the smoothed surface is barely worn and the lower surface shows no use traces at all. Yet, processing traces of cereal or siliceous plants are present within the gloss.

Site S4

The selection of tools on site S4 was a relatively easy one to make. The complete grinding tool excavated in 2005 was chosen to confirm its use as a grinding implement. The third tool was chosen for its deviating surface. Instead of a flat surface this artefact's face is irregular with protruding areas.

The complete grinding tool combines a hammerstone / anvil / grinding stone combination as handstone with an anvil / grinding stone combination as netherstone. The first has strongly developed traces of processing cereal grains or grasses in multiple directions (*no. G92-03561-1*, see catalogue no. 141, pl. 30, quartzitic sandstone). On the upper surface of the second tool, a clear and strongly developed gloss of contact with grains or grasses / siliceous plants is visible (*no. G92-03561-2*, see catalogue no. 136, pl. 28, gneiss). The clear traces on the lower surface resemble the lower surfaces of the grinding stones of Geleen-Janskamperveld (Verbaas 2005, Verbaas & van Gijn 2007). These traces are the result of the positioning of the grinding stone on a hide, or something similar, to collect the ground material. The third tool with the protruding patches is used more intensely (*no. G92-04501*, see catalogue no. 131, pl. 26, gneiss). The higher patches are completely smoothed to polished whereas the lower areas show nearly no smoothing. Processing traces of grains or siliceous plants are clearly visible. The orientation of use is variable, from longitudinal to transversely. The lower surface shows only minor smoothing. Although this tool seems to be used more intensely than the others, the lack of clear or well-developed traces on the lower surface of the tool make Verbaas conclude that the tool was used over only a short period of time. However, a different use or contact material may result in less clearly developed traces as well.

4.5.3 Axe fragments

The two polished stone axes are two differently shaped fragments. The first tool is a large axe fragment broken through the hourglass perforation which was found on site S3. This particular axe fragment was first of all chosen because of its exceptional and rare shape. Secondly, several researchers who have seen the object over the past four years have expressed their reservations on the functionally of such a strangely shaped axe. The axe has an asymmetrical shape and the cutting edge is positioned obliquely to the perforation. Yet, the gloss inside this perforation, indicating friction, proves it was most definitely used, a conviction not shared by the other researchers. The use of the tool thus needed to be established as well as its purpose or function. The second tool is a long blade-like fragment of the side of an axe retrieved at site S51. The reason for this choice is the extensive polish on the fracture plane of the fragment.

Site S3

The first fragment still shows some natural surfaces on the sides as it is produced out of an old cobble with a suitable shape (no. 29245, see catalogue no. 76, pl. 19, porphyry) (see section 4.8.2). By using a cobble with a suitable shape the modelling of the axe could be limited to a minimum, and this explains its unusual shape. The cutting edge is located asymmetrically in relation to the perforation; still the axe is in perfect working condition. Inside the perforation a friction gloss is clearly visible. This gloss is the result of hafting and the usage of the axe. The cutting edge also shows a clear gloss as the result of usage. Unfortunately, the contact material could not be defined.

Site S51

This long blade-like fragment is broken off at the side of the axe, starting at the cutting edge[16] (no. 1564, see catalogue no. 156, pl. 34, quartzite). The plane of fracture is clearly rounded off as a result of wear. Wentink (van Gijn et al. 2007) suggests this might have been the result of the object being carried around in someone's pocket or bag for over a long time. Furthermore, the end opposing the cutting edge shows possible traces of use. If the cutting edge was used after the fragment detached from the axe, these traces at the end could be explained as hafting traces. Unfortunately, the nature of the raw material prevents more conclusive interpretations. The given interpretations are therefore mere possibilities and no definite explanations.

4.5.4 Amber pendant

Research revealed that, contrary to the pendants and the beads worn by the adult man of grave IX on site S2, the amber pendant found in the child's grave on site S4 (no. G92-G1-7, see catalogue no. 140, pl. 29) did not show any macroscopically visual traces of being worn. Therefore, it was presumed that the pendant was not worn or at least not over an extended period of time (Devriendt 2008c: 390). As the opportunity presented itself, the pendant was analysed microscopically to confirm or refute this conception. Both Verschoof and van Gijn corroborate that the pendant was worn but only for a short time. A light gloss has started to develop around the perforation.

4.5.5 Discussion and interpretation

Grinding stones

These grinding stones, both handstones and netherstones, are almost all used for the processing of plant material. Whether this is grain, grass or some other type of siliceous plant can however not easily be attested with this type of analysis. The single tool possibly without traces of siliceous plant material is a hammerstone / polisher combination on site S3 (no. 46624). Although the contact material on this tool could not be defined, this might still indicate a different use of such tools made on pebbles, or it might simply suggest that pebbles, having a rather smooth surface by nature, are less suited for analysis. As it is the only polisher analysed on the presence of use-wear traces, this is only a hypothesis. With the rest of the tools grain or grass traces are often visible on both the upper and lower surface, especially for the tools with two opposing flat surfaces. It was observed that, when two opposing surfaces showed traces, one was always used more intensely than the other. This is the result of the upper surface being used and the lower surface, positioned on the ground or a hide or something, developing a friction gloss. On one of these less used surfaces (no. *00003) the traces are much less developed making a definition as processing traces of grain or grass uncertain. It is a triangular anvil / grinding stone combination on site S3. The other handstone with triangular cross section (no. 50510) is also used only briefly. The lack of traces on the lower surface of one of the anvil / grinding stone combinations (no. 28135) and the two hammerstone / anvil / grinding stone combinations (no. 02017, no. *00001) on site S3, make Verbaas conclude that these tools were also used for a short period of time. It must be said, that the traces on the grinding

16 The use-wear specialists expressed their reservations about the definition of the axe fragment. The pointed end, interpreted by me as the cutting edge, is seen by them as either the cutting edge or the butt of the axe.

tool on site S4 (no. G92-03561-2) are indeed much more developed, both on the upper surface and on the lower surface. Furthermore, two handstones showed clear patterns of direction within the processing traces (no. 1602, no. G92-03561-1). Both longitudinal and a combination of multiple directions occurred. Whether this is related to their different shape, or whether this is just coincidence cannot be determined at this point. As with the polisher, more tools should be analysed on use-wear traces to clarify this matter.

Thus, traces of the processing of cereal grains or other siliceous plant material are detected on all but one grinding tool. These traces are the same on the tools from the different sites, indicating the same kind of plant processing activity on all analysed levee sites.

Axe fragments
The use-wear analysis confirms that both axe fragments have been used. However, the nature of the contact material could not be defined in either case. More important still is the confirmed use of the axe with the tilted cutting edge from site S3. The unusual shape of this tool did not prevent it from being used. This might indicate the high value and high necessity of axes at the sites near Swifterbant. The re-use of the axe fragment from site S51 shows this as well. Yet, the limited size of the axe fragment makes one wonder if it was used in the same way as the much heavier fragment from site S3. As the clear polishing traces on the fracture plane could not be defined, it might have had a different function. In that case, the re-use might also indicate opportunism; why produce a blank when you already have one available? Also, the exotic material might give the newly created object more value. With this re-use, or the recycling of objects, a shift in function, meaning and value may be involved.

Amber pendant
The microscopic wear traces on the amber pendant of site S4 prove that the ornament was worn. Yet, the traces are only light and minor meaning that the pendant was worn but only over a short period of time. This is in accordance with the young age of the child. Yet, several short comments must be made. As the wear ratio of amber has not yet been investigated, it is still unknown how long the pendant was worn. The first research attempts in this direction have begun. During the experiments of Verschoof (2009) amber beads were worn continuously for approximately 2.5 months. This resulted in some areas of gloss around the perforation. Yet, the experiment only consisted of beads that could freely move around the string[17], spreading the traces more or less evenly. When a pendant is perforated, it will hang from the string, concentrating the traces of friction on the upper part of the perforation. Furthermore, the weight and the size of the artefacts was not taken into account; a pendant with a larger size and weight will wear more rapidly than a pendant of a smaller size and weight. In addition to this, the freedom of movement along the string increases the speed of wear even more. Thus, taking all these aspects into consideration, the wear rate of a pendant or bead is presumably highly variable making it difficult to determine the duration of wear. However, the estimation that the child buried on site S4 wore the pendant for a short period of time is presumably correct as the traces are very minor.

17 The two types of string that were used were stinging-nettle and leather (buckskin).

4.6 Residue analysis

4.6.1 Introduction
In order to compare the phytoliths[18] generated by the grinding stones several soil samples were analysed as well (Nieuwenhuis et al. 2006).[19] The samples were part of a larger soil sampling project during the 2005 excavation campaign on site S4. The two soil samples that were selected for this analysis were chosen in relation to the finds location of the grinding tool. Sample B135 was collected in the same excavation unit as the tool. The other soil sample, B118, was taken at the opposite side of the trench, some four to five metres to the east but at the same horizontal level as the tool. These two soil samples are discussed separately.

4.6.2 Grinding stones
As the Swifterbant artefacts of the old excavations were never thoroughly studied, they were never properly washed or cleaned. This is of great importance for phytolith analyses as residue is vital. Extra caution was therefore applied to the grinding tool from site S4 when it was found in situ. Nieuwenhuis started by soaking the upper part and lower part of the tools separately in distilled water. This water was sampled and prepared for microscopic analysis. Certain areas of certain tools were lightly brushed and sampled again. In order to register and define all sorts of residue no chemical additives were used. The chemical process to isolate phytoliths will destroy for example starch grains. Whether different micro-remains are distinguishable from one another without chemical treatment is strongly dependent on the composition of the soil at the site. Luckily, the soil conditions in the Swifterbant area are favourable. Although the prepared

18 Phytolith: a minute mineral particle formed inside plant tissues by the deposition of silicates, often surviving as a microfossil in geological or archaeological deposits (Oxford English Dictionary Online 23.04.2009).

19 As part of the use-wear analyses on grinding stones (see section 4.5.1) a residue analysis was also conducted in November 2006 and September 2007 at the Laboratory of Artefact Studies (Leiden University) under supervision of Annelou van Gijn.

Table 4.8 Number of artefacts analysed in the two residue analyses.

	Site S3	Site S4
Grinding stone	1	1
Hammerstone / Grinding stone	2	
Anvil / Grinding stone	2	1
Hammerstone / Anvil / Grinding stone		1
Total	5	3

samples contained a lot of non-diagnostic material, many phytoliths were clearly distinguishable, just as a few starch grains.

All analysed tools were selected from the group that was already under investigation (table 4.8). In this way the use-wear traces could be compared to the results of the residue analyses. Only the artefacts that were most likely to be holding phytoliths were chosen.

Site S3

The first tool is a grinding stone with one smoothed surface (nos. 20770 + 7613, no. 49, pl. 10, gneiss). This netherstone yielded only a very small amount of phytoliths. After brushing and renewed sampling this remained the same. A starch grain was also found but this could not be determined to species. The second tool is a hammerstone / grinding stone combination also with two opposing surfaces (no. 900141, no. 64, pl. 15, quartzitic sandstone). Although only one surface was smoothed the two surfaces produced equal low amounts of phytoliths. Again, this remained the same after brushing and re-sampling. The third analysed tool, the triangular anvil / grinding stone combination has a clearly smoothed surface (no. *00003, no. 62, pl. 14, granite-gneiss). Yet, the residue analysis generated almost no phytoliths. After brushing a limited number was collected. The first of the two anvil / grinding stone combinations generated phytoliths from both smoothed surfaces (no. 26403, no. 59, pl. 13, quartzitic sandstone). The phytolith fragments from the lower surface were smaller than those retracted from the upper surface. Brushing and renewed sampling resulted in a wider variety of phytoliths. The second anvil / grinding stone combination also yielded a small amount of phytoliths existing of rather small fragments (no. 28135, no. 60, pl. 13, quartzitic sandstone).

Site S4

The handstone of the grinding tool yielded almost no residue (no. G92-03561-1, no. 141, pl. 30, quartzitic sandstone), with mainly non-diagnostic fragments. After brushing and renewed sampling a wider variety of phytolith fragments appeared. The netherstone produced a remarkably high amount of phytoliths, equally much on the upper as on lower surface (no. G92-03561-2, no. 136, pl. 28, gneiss). This sample showed all types of phytoliths and this remained the same after brushing and re-sampling. The third tool, a large netherstone with two opposing surfaces, showed smoothing on both surfaces (no. G92-04501, no. 131, pl. 26, gneiss). The large amount of phytoliths found on this tool was composed of many different types of fragments. Also, a considerable amount of charcoal fragments was detected as well.

4.6.3 Soil samples

As with the grinding stones, the soil samples were processed without chemical additives (Nieuwenhuis et al. 2006). In this stage several phytolith samples were taken per soil sample. Only in a later phase was chemical processing conducted.

The first soil sample (B135), coming from the same excavation unit as the grinding tool from site S4, contained large quantities of phytoliths in many different types of fragments. Besides these *Poaceae* phytoliths, a small number of *Fabacaea* phytoliths could be isolated. The second soil sample (B118) from the opposing side of the trench, also contained large amounts of phytoliths. The composition of this sample is very similar to the other sample with the exception that no *Fabacaea* phytoliths occur. It was observed that the phytolith fragments in the soil sample are larger than those collected from the grinding stones.

4.6.4 Discussion and interpretation

Although the number of phytoliths per tool is limited, and the sample of tools is rather small, differences in quantity per tool type could be observed. On most of the handstones hardly any phytoliths are present whereas the netherstones produce noticeably more of them. The intensely used netherstone of site S4 also showed the largest amount encountered. Although all phytoliths come from grasses (Poaceae), their different shapes are indicative of certain types of grasses, for example the hat-shaped phytolith of the Cynodon dactylon (Bermuda grass). Other shapes are characteristic for grasses that evaporate large quantities of water. The occurrence of various types of fragments, such as long and short cells and hairs, signifies that all parts of the plants were processed, both leaves and stems and presumably roots as well.

The soil samples show roughly the same picture. The predominance of grasses (Poaceae) could be attested. Only one phytolith sample from soil sample B135 also contained Fabacaea phytoliths (legume family). It was observed that the number of phytoliths in the soil samples is overwhelming large compared to the grinding stones and that their size is also bigger. These phytoliths distinguish themselves from the ones on the grinding tools as the latter are the result of the processing of the plant material which fragmentises the phytoliths.

The sampled phytoliths were compared with those of emmer wheat and naked barley. Although there are morphological similarities, which also occur with other types of Poaceae, the sizes are different. The phytoliths at Swifterbant are significantly smaller. This could be related to the fact that the plants may be very early cultivars. At the time of the analyses, no such referential material was present in the laboratory. Other characteristics of the Swifterbant material, such as the shape of the cells or the delineation of the edges or fractures, are different from those of cultivars, yet could not conclusively be distinguished from one another. Maybe new soil samples from the hoe-field on site S4 will provide reference material for future research.

In conclusion, there seems to be a relation between handstones and a low number of phytoliths, and netherstones and a larger number of phytoliths. Also, the number of phytoliths seems to rise with the intensity of usage of the tool. All the phytoliths, from the first study and the second study but also from the different sites, are alike indicating the processing of similar plants. Although the soil samples are richer than the tool samples, the same phytoliths are present. The traces of Fabacaea in the soil are, however, too few to be able to pronounce upon the wider variety of plants at the site. Finally, there is no conclusive evidence of the processing of cultivated grains. Yet, evidence of different kinds of grasses (Poaceae) and maybe of early cultivars is present.

4.7 Observations on spatial patterning

4.7.1 Introduction

At a few of the old excavation campaigns of Swifterbant, the artefacts were recorded three dimensionally. For example, at site S3 the larger artefacts were hand collected and the remaining soil was sieved to recuperate even the smallest pieces of flint, stone and other archaeological remains. However, the loss of nearly all of these three dimensional coordinates and other spatial information, like the sieving information, clearly hinders this part of the research. The limited information that is still available is restricted to site S3 and S61.[20]

4.7.2 Site S3

A large part of the spatial analysis of the archaeological remains, apart from flint or stone artefacts, has been done already by de Roever (2004). Several of her plans are therefore used as a starting point for the analysis here at hand. One of the major contributions of Pauline de Roever was the discovery of the house on site S3. The position of many of the posts and postholes clearly outline the floor plan of a rectangular house of c. 4.5x8 m (figures 4.19 – 4.22). In the centre of the house a hearth is visible. This is a hearth that was repeatedly rebuilt on the same spot from the lowest layers onwards up until the end of the occupation (de Roever 2004: 34).

The largest set of information still available is that of the stone artefacts from site S3. The x and y coordinates of most of the hand collected stone artefacts are still existing. The same applies to the stone artefacts retrieved from the sieved excavations units. However, the third dimension, the depth, is less easy to use in this analysis. Because of the loss of primary information it is nearly impossible to combine the two different registration techniques[21] and provide a reliable vertical analysis. Therefore, the spatial analysis will be restricted to a horizontal analysis alone. Still, as the x and y coordinates of 10,443 stone artefacts could be retrieved, the upcoming horizontal spatial analysis is based on 97% of the stone industry.

The spatial maps are created with Surfer 8.0 (Golden Software) and are drawn in two ways. In the first type of map each artefact is resembled by a symbol (classed post map). This is a good way of representing the three dimensionally registered artefacts (see figures 4.28 – 4.29). The second type of map draws contours around areas with a certain density of artefacts (contour map)[22]. These are very useful in bringing the sieved material into vision. When the coordinates of the three dimensionally registered artefacts are recalculated, they can be joined with the sieved material and all artefacts can be shown in contour maps (see figures 4.24 – 4.27). The sieved material cannot, however, be recalculated to fit into the classed post maps of the three dimensionally registered artefacts.

Before turning to the spatial analysis two issues need to be addressed. First of all, the amount of sieved material (68%) is high compared to the hand collected material (29%). Therefore, their part in the image building of the maps is considerable. As nearly all the information on the sieved stone artefacts could be retrieved (figure 4.23) the image resulting from this information is believed to be representative. The excavation units represented by white squares did not contain stone artefacts. However, it could not be determined, at least not for all of them, whether this means that there really were no stone finds or whether the information was lost or poorly registered.

20 The new excavations at site S4 also enable spatial analysis of the stone artefacts (Geuverink in prep.).

21 The hand collected artefacts were recorded by three dimensional coordinates, for example 605x1907x569. The sieved material was numbered by excavation unit, for example VIx19xF. Axes x and y are easily recalculated to one system, and can thus be combined. The exact depth of the excavation surface, or of each layer of excavations units, could no longer be retrieved with sufficient reliability to use, or combine, the data from the sieved excavation units. The amount of information of the three dimensionally registered artefacts is, however, also insufficient to provide a reliable spatial image.

22 The contour maps are made using the kriging method application in Surfer 8.0.

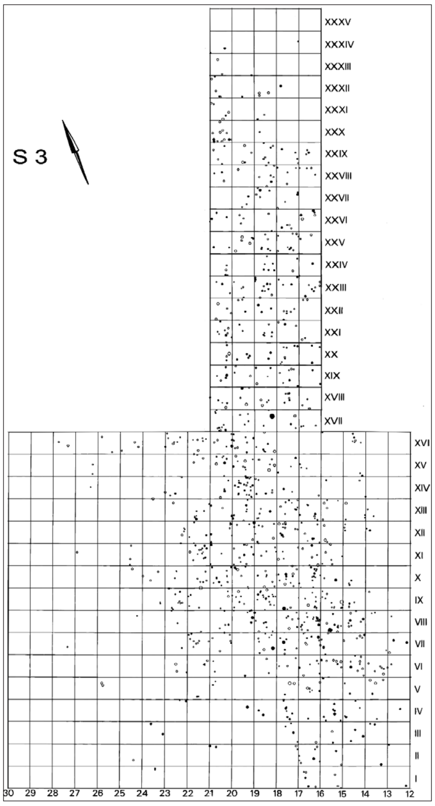

Figure 4.19 Posts and postholes at site S3 (adapted from de Roever 2004). Dots: posts, circles: postholes.

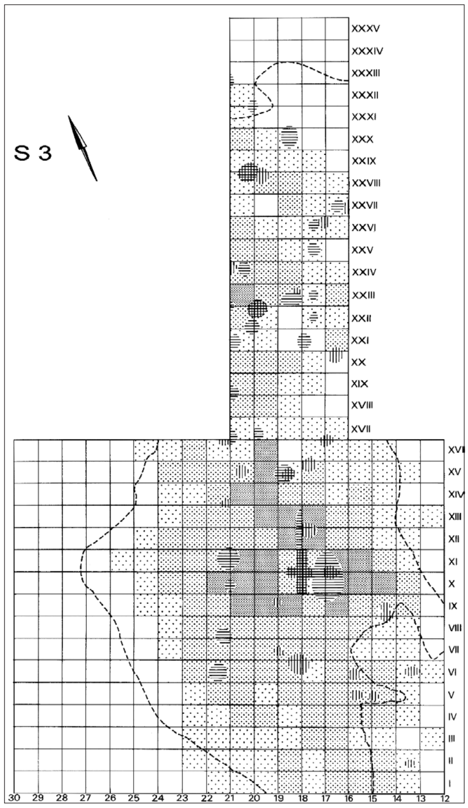

Figure 4.20 Density of potsherds and hearths at site S3 (taken from de Roever 2004). Grey scale: potsherd densities, hatched: hearths, dashed line: area with flint concentrations.

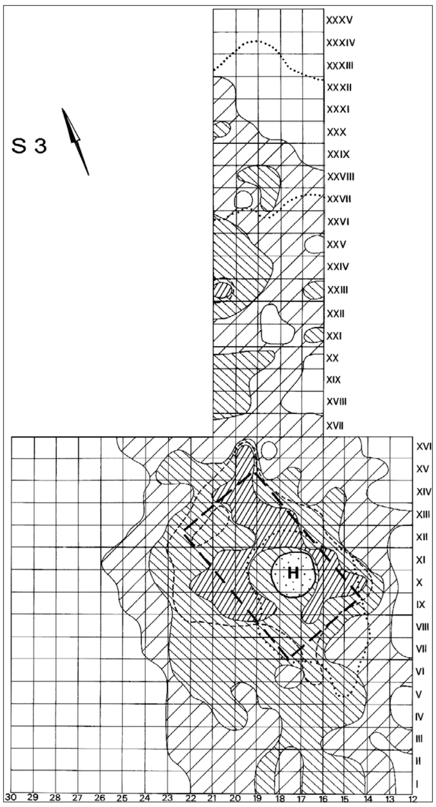

Figure 4.21 Schematic representation of the house, central hearth, and density of potsherds at site S3 (taken from de Roever 2004). Hatched: potsherd densities, dashed line: 90 potsherd per m², dashed rectangle: house, dotted line: contour line at 5.45 m –NAP, H: central hearth.

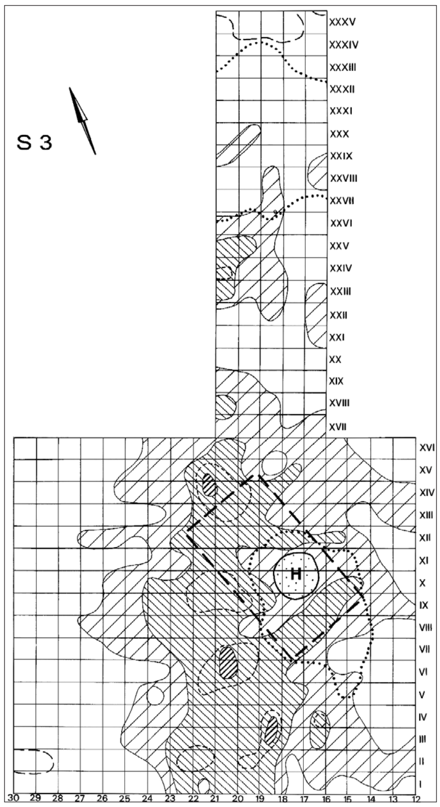

Figure 4.22 Schematic representation of the density of bone material at site S3 (taken from de Roever 2004). Hatched: bone densities, dashed line: 90 bone finds per m², dashed rectangle: house, dotted line: contour line at 5.45 m –NAP, H: central hearth.

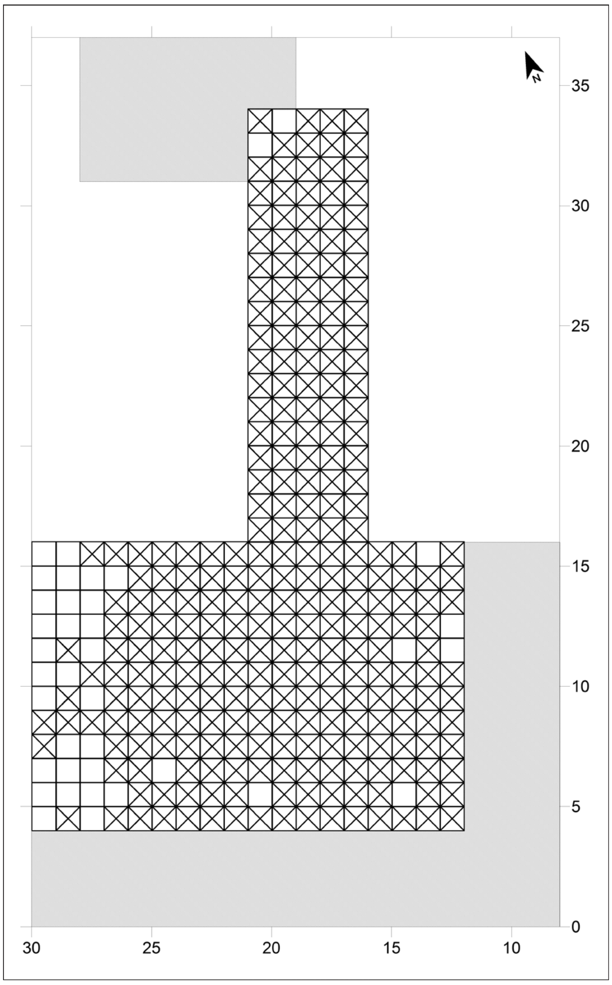

Figure 4.23 Schematic representation of the sieved excavation units within the excavation area at site S3 (black cross: positive on stone artefacts, white box: negative on stone artefacts or no information, shaded part: trench).

Second, as the image in all the contour maps is largely built up by the information of sieved excavation units, the image is strongly affected by the border effect. The density of the contour lines in the north and eastern boundaries of the maps is therefore artificial and does not represent a prehistoric reality. Only the southern and western part of the stone concentration shows a diffuse image that is presumably true to the prehistoric reality, i.e. lower densities of artefacts at the rims of the occupation area.

When the artefacts < 3 g are plotted onto a contour map it is clear that the material forms three small clusters (figure 4.24). They are located near the highest parts of the levee. However, when the artefacts ≥ 3 g are plotted the pattern is more diffuse, not only showing higher densities near the three clusters of small material but also showing some more small clusters (figure 4.25). As the smaller stone fragments make up 80% of the material in this spatial analysis, it is their scattering pattern that is decisive when all artefacts are plotted together (figure 4.26). The smallest material is also less likely to be moved and is therefore a good parameter for spatial patterning of activity zones. It appears that the cluster with the most material (concentration 1) is located near the centre of the whole site. Another cluster (concentration 3) is located on the other elevation of the levee, whereas concentration 2 is located in between.

When this information is combined with 'Pauline's house', concentration 1 lies just within its limits, whereas concentration 2 lies in front of the house (figure 4.27). Concentration 3 is located somewhat away from the house, on a spot presumably chosen for its elevated position. It may also be clear that the material within the house is mainly scattered around the central hearth.

Another way of visualising the material is by 'classed post map'. Each stone artefact, large or small, registered in a three dimensional way is set against the plot of posts and postholes (figure 4.28). The house outlined by de Roever is clearly visible as a void in the spread of the stone artefacts, i.e. the area inside the house shows less material than the area outside the house. Also, the walls are clearly visualised by material being propped up against them. In the area around 'Pauline's house' more rectangular outlines become visible, all with the same orientation. As these outlines overlap the patterns must have been created by different phases of a single house and not by different houses during the same occupation phase, as the latter would lie side by side. The line of posts and postholes running from the house to the south is possibly not the side of such a house but some sort of construction or palisade as it runs towards a cluster in the material (figure 4.25). In total, at least four different house outlines, or parts thereof, could be distinguished in the spread of posts and postholes (figure 4.29). Now the orientation of the house is known, more posts and postholes seem to follow that pattern and may indicate even more phases of the same house, or related constructions. However, these are not always related to voids, or other patterns, in the spread of the stone artefacts. Yet, it appears the different house plans are to be related to the central hearth. The hearth of each house is located at roughly the same spot as that of the previous house, all resulting in one big central hearth. Alternatively, as the hearth may be seen as the focal point of a house, the houses are rebuilt around the central hearth.

By plotting the different tool types, certain activity areas may be discerned within the spread of the artefacts. When all tools are plotted together most of them are located in front of and near the house (figure 4.30). A cluster of tools is visible near concentration 3 and a small cluster of many tools located tight together is discernible at the south end of the site. This is the area where a small trench towards site S6 was dug. As all the spatial information of site S6 is lost, it is unclear how big this cluster is. However, up to 7

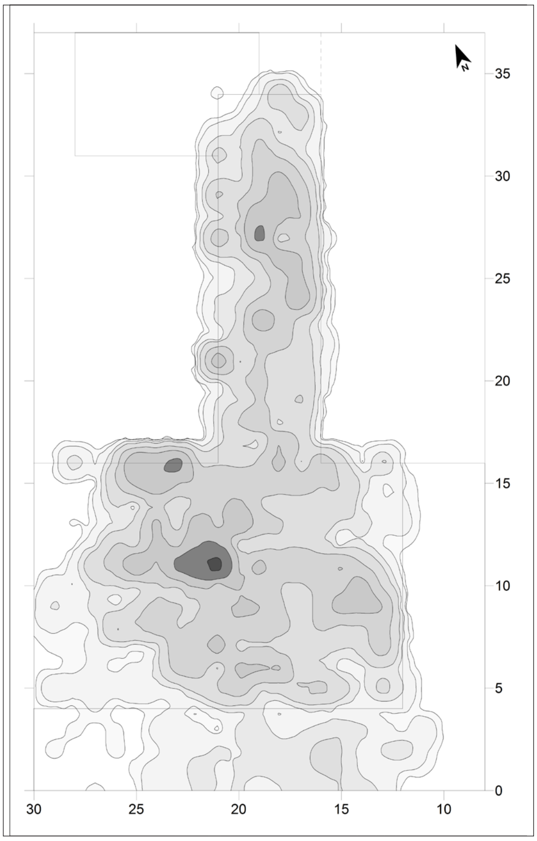

Figure 4.24 The artefacts < 3 g from site S3. Contour lines set at 1, 5, 10, 25, 50, 150, 100, and 200 artefacts.

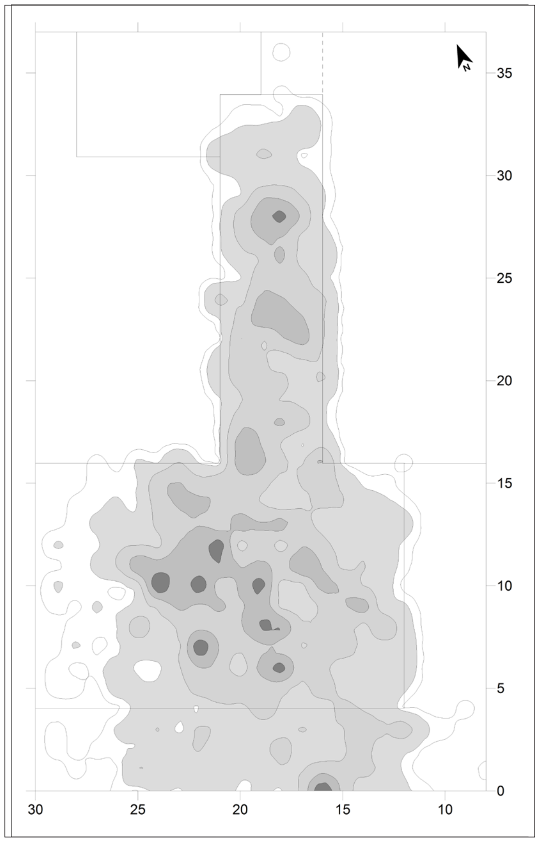

Figure 4.25 The artefacts ≥ 3 g from site S3. Contour lines set at 5, 10, and 15 artefacts.

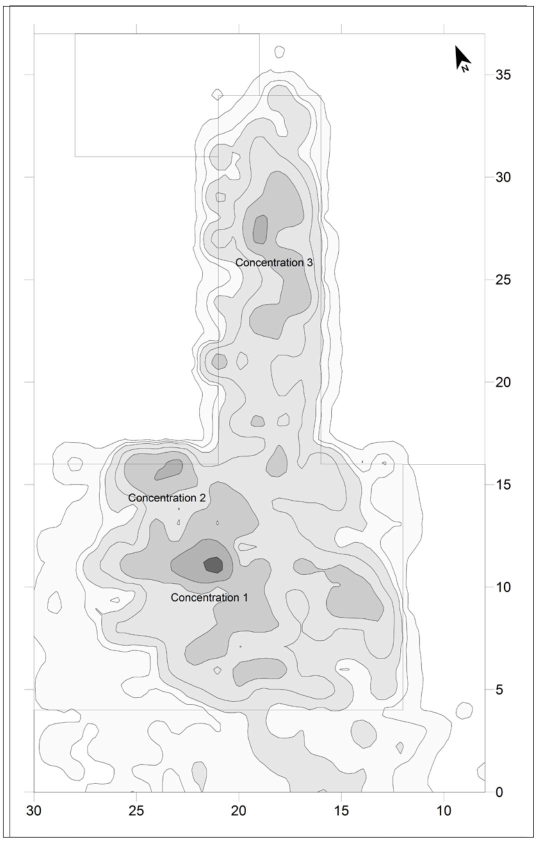

Figure 4.26 The artefacts (both ≥ and < 3 g) from site S3. Contour lines set at 1, 5, 10, 25, 50, 100, and 200 artefacts.

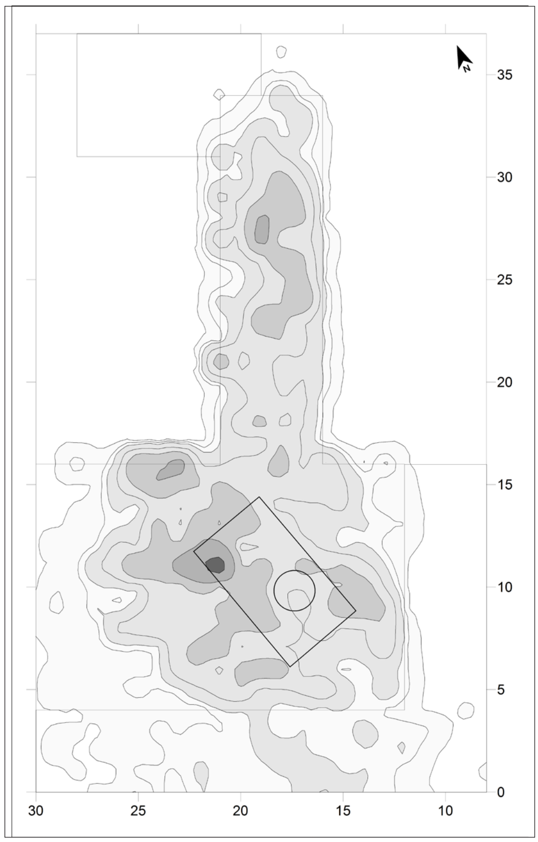

Figure 4.27 The artefacts (both ≥ and < 3 g) from site S3, combined with 'Pauline's house'. Contour lines set at 1, 5, 10, 25, 50, 100, and 200 artefacts.

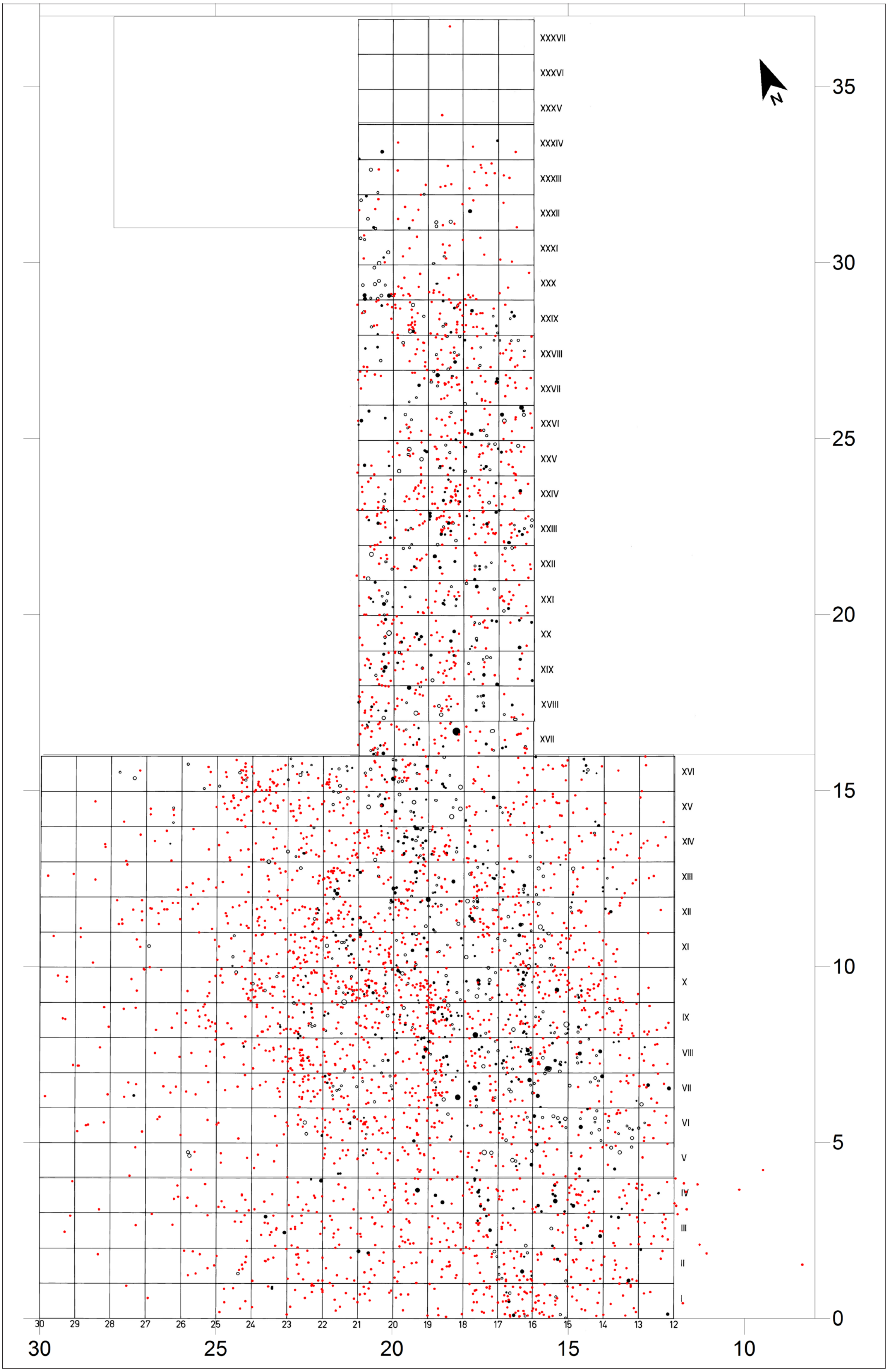

Figure 4.28 The three dimensionally registered artefacts (both ≥ and < 3 g) from site S3, combined with the posts and postholes.

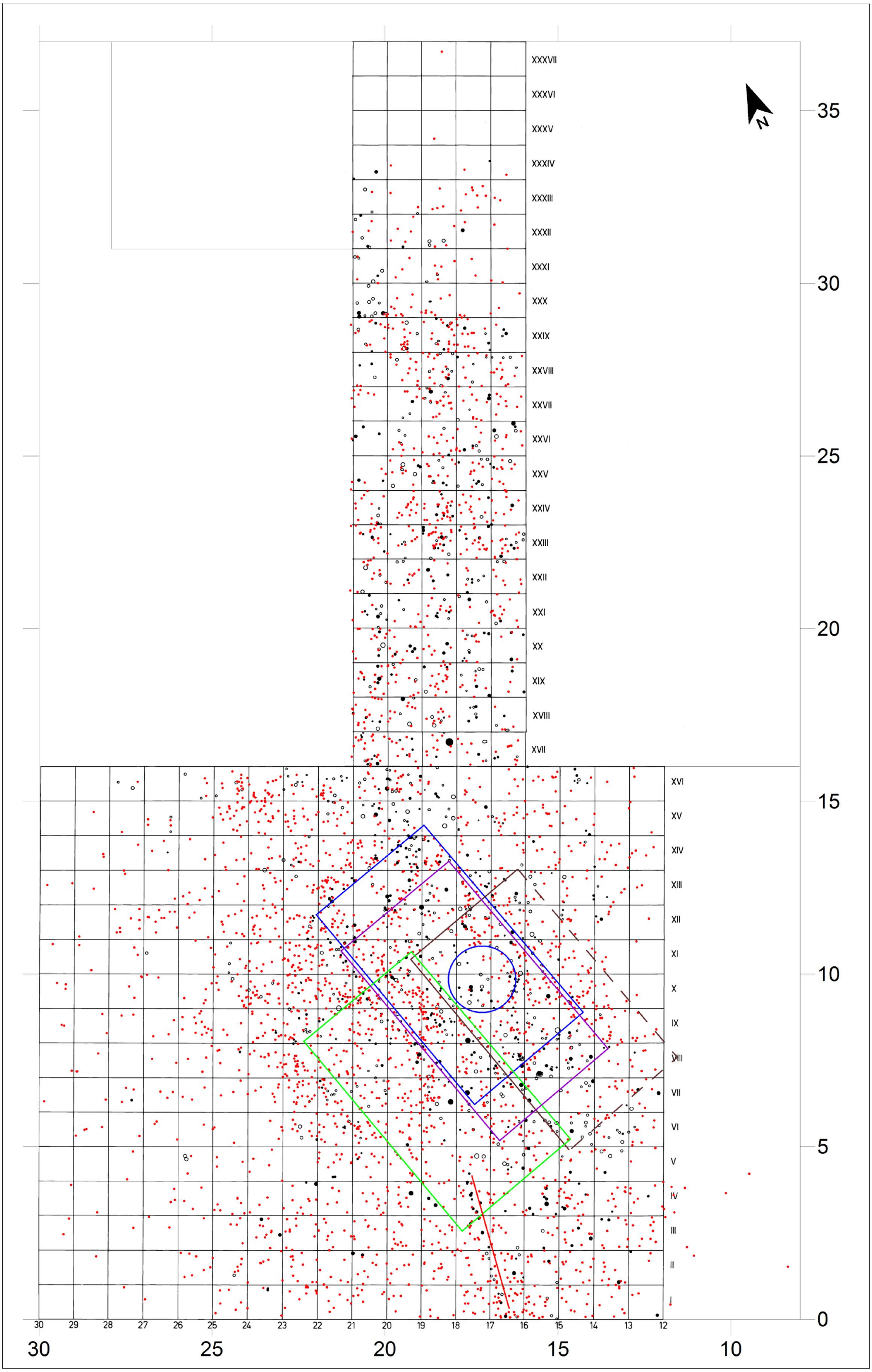

Figure 4.29 The posts and postholes from site S3, combined with the different phases of the house.

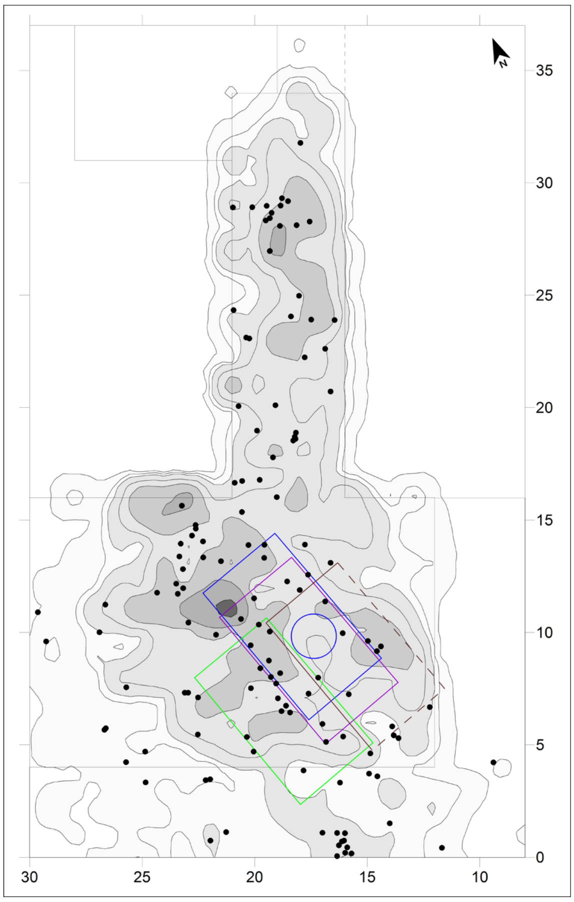

Figure 4.30 All the tools (black) at site S3.

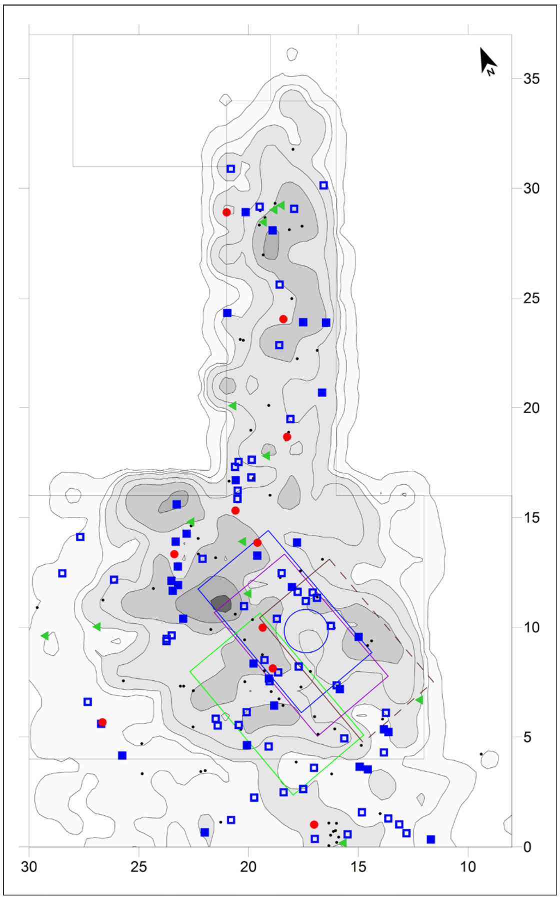

Figure 4.31 The anvils (green), the grinding stones and ground stone fragments (blue) and the hammerstones (red) at site S3.

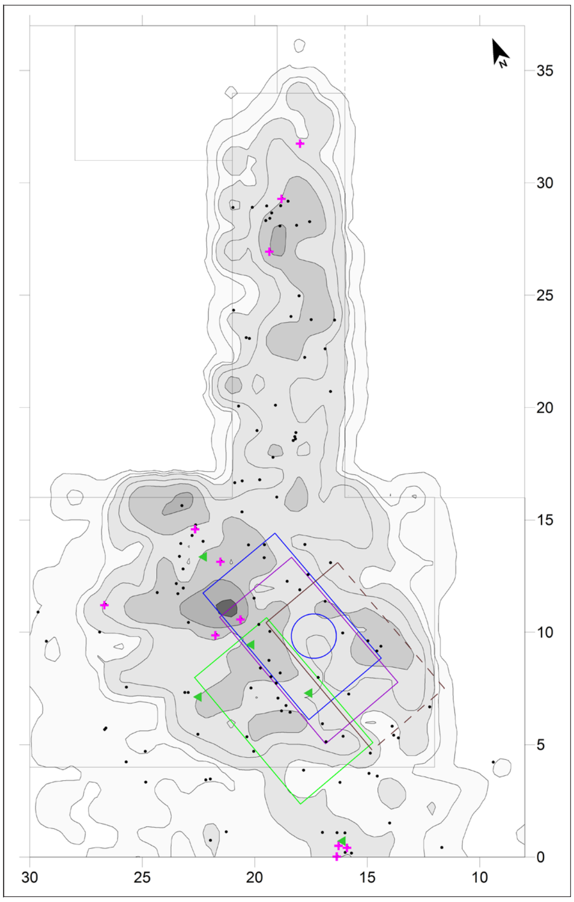

Figure 4.32 The anvil / grinding stones (green) and the hammer / grinding stones (pink) at site S3.

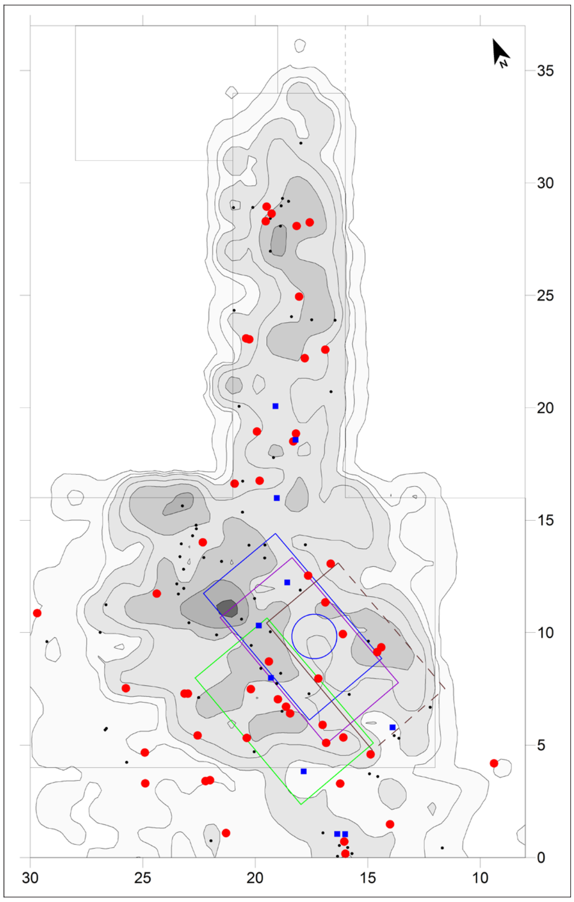

Figure 4.33 The hammer / anvil stones (red) and the hammer / anvil / grinding stones (blue) at site S3.

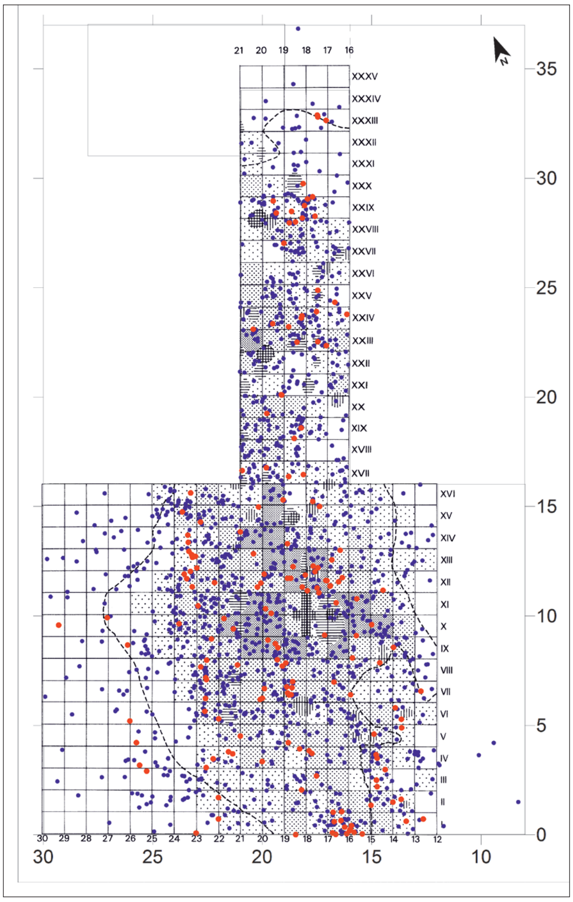

Figure 4.34 The artefacts ≥ 3 g (blue) combined with the heat exposed artefacts (red) at site S3.

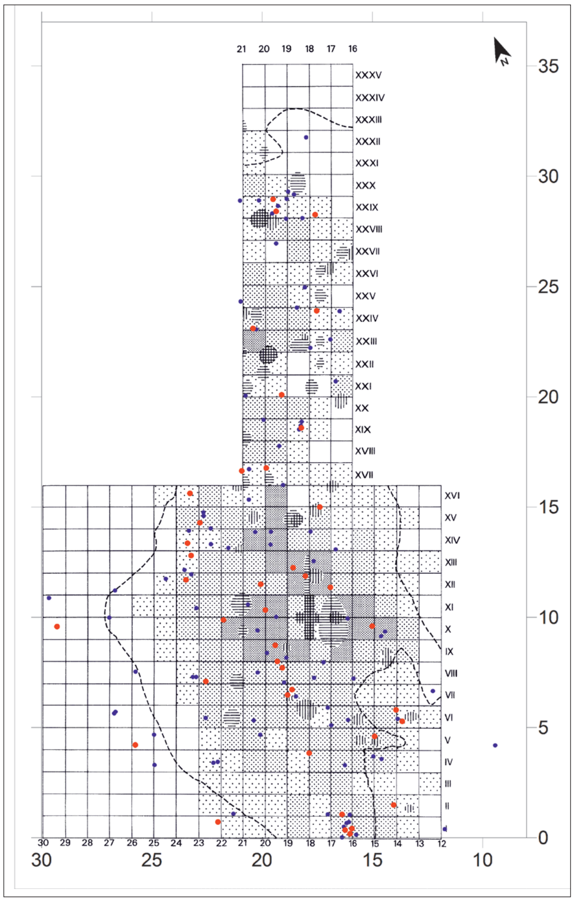

Figure 4.35 The tools (blue) combined with the heat exposed tools (red) at site S3.

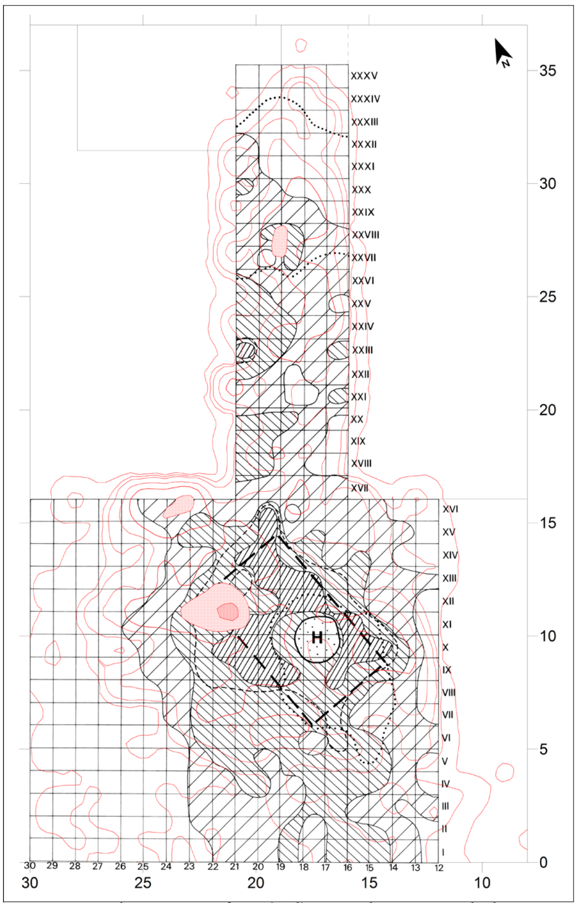

Figure 4.36 The stone artefacts (red) in combination with the pottery at site S3.

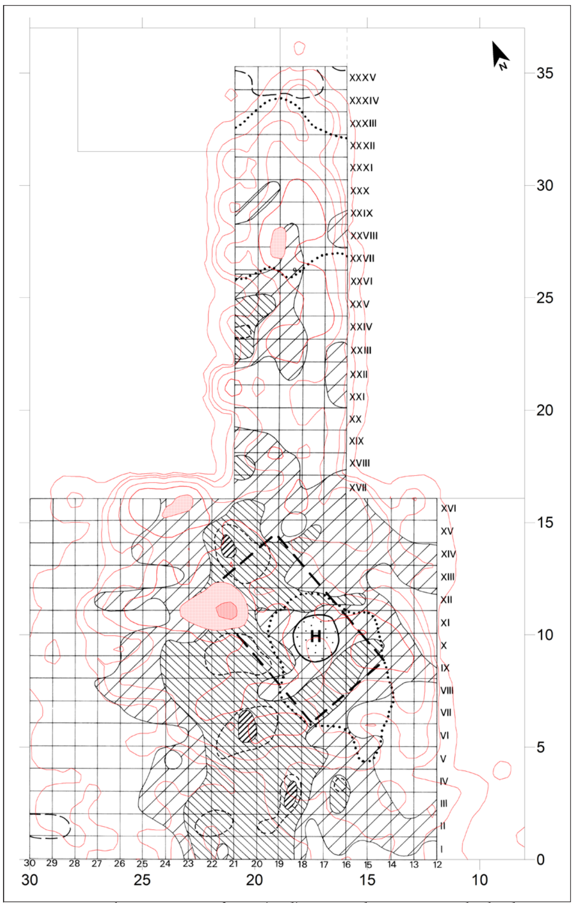

Figure 4.37 The stone artefacts (red) in combination with the bone fragments at site S3.

tools were found in this small trench making the cluster even more important (see catalogue table 1.5).

By singling out specific tool types clearer divisions may be observed. For example, the anvils mainly cluster near concentration 3 (figure 4.31, green triangles). On the other hand, the grinding stones seem to be located nearer to the house. This image is even enhanced when all ground stone fragments are included (figure 4.31, blue squares). Yet, for the hammerstones this is not the case. They appear not to be clustering at all (figure 4.31, red dots). Their low number might, however, complicate the comparison. The images of the multiple activity tools are somewhat similar. The anvil / grinding stones are located near the house (figure 4.32, green triangles) whereas the hammer / grinding stones are split up in three clusters (figure 4.32, pink crosses). The hammer / anvil stones are harder to interpret, they at least show one cluster near concentration 3 (figure 4.33, red dots). However, some of the tools are also located near the house. Finally, the hammer / anvil / grinding stones seem to be located in the vicinity of the house (figure 4.33, blue squares).

When the artefacts are plotted against the hearths, it appears that the material is located nearly everywhere except inside the hearths itself. Even the majority of the burnt artefacts are located outside the actual hearths (figure 4.34). For the tools this is exactly the same (figure 4.35).

As a final stage, the spread of the stone artefacts can be compared to the pottery and bone densities. The potsherds (figure 4.21) are most densely spread around the central hearth, mainly inside Pauline's house, and in the lower lying area in the north (line XXIII). It appears the highest stone density (concentration 1) is also lying in the house, yet in the northwestern sector, just in the area where potsherd densities are lower (figure 4.36). Stone concentration 2 is lying just beyond the bulge in the pottery spread at the northern end of the house, in an area with even less potsherds. Finally, the little concentration of potsherds in the north is located in an area with low stone densities.

The bone fragments (figure 4.22) have several little clusters of high density outside the house, both in northern as in southwestern direction. Lower densities can be found inside the house around the hearth, in the area around the house also in south(western) directions, and in the lower lying area in the north (line XXIII – XXV). As with the pottery, it appears that the areas with the highest densities in bone material lie adjacent to the areas with the highest stone densities; this is even so in the northern, lower lying area (figure 4.37).

To sum up, it appears that most tools are located around the clusters of smaller material. Yet, some of them have their own pattern. At the south end of the site a clear cluster of tools is visible, the same accounts for the elevation at the north end. The remaining tools are especially located at the west and north side of the house. It also appears that, in general terms, the tools with a grinding function are located near the house, whereas anvils appear to be located at some distance away from the house, both in northeastern and in southern areas. For the hammerstones no apparent clustering could be discerned. The material is spread around the hearths, with no apparent distinction between burnt and unburnt artefacts or tools.

4.7.3 Site S61

The little spatial information of site S61 can be found in de Roever (2004) (see section 2.6.15) and is limited to the vertical distribution. It regards the presentation of the different layers found at the site. The only stone artefacts of which this information is still available are part of the sieved material. This is 82% of the stone artefacts.

Both de Roever (2004: 29) and Deckers et al. (1980: 142) concluded that the layers K and L are later, possibly even Neolithic, than layers A-C, which are Mesolithic. Most of the stone fragments in this little spatial analysis are found in layers K and L. This would suggest, if we believe this little sample to be representative of the whole assemblage at the site, that the stone material is largely of Neolithic origin. The amber ornament was however gathered from layer A, just as a small pebble. This does not need to imply the Mesolithic age of the ornament, as layer A is located directly below layer K and it was observed that the layers are not strictly separated but gradually fade into each other. Also, two small and light fragments of amber may easily be subject to migration.

4.8 Synthesis, comparison and interpretation of the stone artefacts

4.8.1 Artefact percentages at all sites

The various numbers of stone artefacts, recovered from eight different sites [23], are not only divided into two weight classes but are also separated by artefact group and artefact type. The numerical presence of these artefact groups is different for each site as each assemblage is characterised by different proportions.

All but trenches S21-S24 have a high proportion of artefacts < 3 g. This percentage fluctuates between 79% and 83% of the total number of artefacts for sites S2, S3 and S51, and reaches as high as 97 % and 99% for sites S4 and S61 respectively. The trenches S21-S24 yielded a much

23 Both site S41 and sites S80-S84 are excluded from most of the sections below as they consist of three and two artefacts correspondingly. For site S41 this is a flake, a hammer / anvil combination tool, and a polished axe fragment. For site S81 and site S83 this is in each case an artefact < 3 g.

Table 4.9 Number of artefacts at the different levee sites at Swifterbant.

	S2		S3		S4		S41 *		S51	
	Number %	*≥ 3 g*	*Number %*	*≥ 3 g*	*Number %*	*≥ 3 g*	*Number %*	*≥ 3 g*	*Number %*	*≥ 3 g*
Debitage material	**192**	**36.2%**	**951**	**42.2%**	**167**	**30.0%**	**1**	**33.3%**	**24**	**47.1%**
Flakes	58	30%	321	34%	55	33%	1		7	29%
Blades	1	1%	12	1%	1	1%				
Chips	99	52%	473	50%	85	51%			11	46%
Cores	34	18%	145	15%	26	16%			6	25%
Tools	**37**	**7.0%**	**244**	**10.8%**	**51**	**9.2%**	**2**	**66.7%**	**10**	**19.6%**
Hammerstones	2	5%	12	5%	4	8%				
Anvils	3	8%	21	9%	8	16%			1	10%
Grinding stones	6	16%	34	14%	10	20%			2	20%
Combination tools	5	14%	92	38%	12	24%	1		3	30%
Ha. / An.	2	5%	58	24%	7	14%	1		2	20%
Ha. / Gr.	2	5%	11	5%	1	2%			1	10%
An. / Gr.	1	3%	9	4%	3	6%				
Ha. / An. / Gr.			14	6%	1	2%				
Polished axes (+ fragm)	2	5%	10	4%	5	10%	1		1	10%
Ground stone frag-ments	19	51%	71	29%	12	24%			3	30%
Retouched pieces			4	2%						
Other	**1**	**0.2%**	**4**	**0.2%**						
Ornaments	**26**	**4.9%**	**51**	**2.3%**	**1**	**0.2%**				
Waste	**274**	**51.7%**	**1005**	**44.6%**	**338**	**60.7%**			**17**	**33.3%**
Indet. fragments	146		660		219				6	
Pebbles / cobbles	96		232		49				3	
Frost flakes / potlids	2		8		1					
Possible debitage / tool	30		105		69				8	
Subtotal ≥ 3 g	***530***	***100%***	***2255***	***100%***	***557***	***100%***	***3***	***100%***	***51***	***100%***
	16.8%		20.8%		3.0%		100.0%		17.5%	
< 3 g	**2625**		**8563**		**17846**		**0**		**241**	
	83.2%		79.2%		97.0%		0.0%		82.5%	
Total	**3155**		**10818**		**18403**		**3**		**292**	

smaller amount of 12%. One immediately thinks this might be related to the excavation technique, whether all soil is sieved or not, but as the excavation technique is presumed largely to be the same, this explanation is most likely not valid. The position of the excavation trench compared to the site itself, in the centre or on the outskirts, might be of some influence.

Of the different artefact categories, the debitage material and the waste material are the most numerous on all sites (tables 4.9 and 4.10). The tools always take third place. Sites S2 and S4 are similar in proportions, whereas site S3 has slightly more debitage material and tools. The three remaining sites are all different with a very high waste percentage for trenches S21-S24, and a high tool count for site S51. The dominance of debitage material on site S61 is obvious as almost all artefacts ≥ 3 g are of that category. When the debitage material is analysed in detail, it is observed that chips dominate on all sites, except in trenches S21-S24, taking up roughly 50%; flakes count for 30% and blades cover up to 1%. A different picture is visible for trenches S21-S24 where a rather low number of chips and a high number of flakes can be observed. The cores fluctuate largely from 8% up to 25% which might point to a different intensity of debitage. When average percentages are drawn up for all the sites together, with flakes 34%, blades 1%, chips 50%, and cores 15%, sites S3 and S4 resemble the most. As these two sites comprise the

Table 4.10 Number of artefacts at the different river dune sites at Swifterbant.

	S21-S24		S61		S80-S84	
	Number %	*≥ 3 g*	*Number %*	*≥ 3 g*	*Number %*	*≥ 3 g*
Debitage material	**126**	**26.5%**	**12**	**66.7%**		
Flakes	71	56%	3	25%		
Blades	2	2%				
Chips	42	33%	6	50%		
Cores	11	9%	3	25%		
Tools	**17**	**3.6%**	**2**	**11.1%**		
Hammerstones	2	12%				
Anvils	3		1	50%		
Grinding stones						
Combination tools	8	47%	1	50%		
Ha. / An.	6	35%				
Ha. / Gr.						
An. / Gr.			1			
Ha. / An. / Gr.	2	12%				
Polished axes (+ fragm)	1	6%				
Ground stone fragments	3	18%				
Retouched pieces						
Other	**3**	**0.6%**				
Ornaments	**1**	**0.2%**	**2**	**11.1%**		
Waste	**328**	**69.1%**	**2**	**11.1%**		
Indet. fragments	136					
Pebbles / cobbles	162		1			
Frost flakes / potlids						
Possible debitage / tool	30		1			
Subtotal ≥ 3 g	***475***	***100%***	***18***	***100%***	***0***	
	44.6%		0.7%		0.0%	
< 3 g	**590**		**2546**		**2**	
	55.4%		99.3%		100.0%	
Total	**1065**		**2564**		**2**	

bulk of the material this is not so surprising. Yet, site S2 holds as much debitage material as site S4 and shows a different pattern.

The comparison of the tool composition is more complicated because the percentages change greatly per tool type and site. For the single activity tools the dominance of grinding stones over anvils and hammerstones is present at sites S2, S3 and S4. This is even more so when all the ground stone fragments are included. Their numerical dominance is an obvious result of their high fragmentation rate. Still, at site S2 their presence is significant. For the combination tools this equation is more difficult. Both sites S3 and S4 have high numbers of combination tools, and hammerstone / anvil combinations in particular.

When the tools are divided by function[24] (tables 4.11 and 4.12), that is a grinding function as opposed to a function as hammer or anvil, some patterns emerge. Again, the numerical supremacy of the ground stone fragments, mostly related to their high fragmentation rate, distorts the picture. When these are excluded, because it is impossible to determine how many grinding tools they originally represent, 6 tools with a hammer function occur on site S2, together with 6 tools with anvil function and 9 tools with grinding function. This calculation results on

24 Every tool has one or more functions. These functions are counted separately, independent of the number of artefacts. For example, 1 hammerstone, two anvils, and an anvil / grinding stone combination tool would result in 1 hammer function, 3 anvil functions, and 1 grinding function. Thus the number of functions may be more than the number of tools.

Table 4.11 Overview of the tool functions at the different levee sites at Swifterbant.

	S2		S3		S4		S41		S51	
	Number %	*≥ 3 g*	*Number %*	*≥ 3 g*	*Number %*	*≥ 3 g*	*Number %*	*≥ 3 g*	*Number %*	*≥ 3 g*
Functions	21		265		47		2		9	
Hammer	6	29%	95	36%	13	28%	1	50%	3	33%
Anvil	6	29%	102	38%	19	40%	1	50%	3	33%
Grinding	9	43%	68	26%	15	32%			3	33%

Table 4.12 Overview of the tool functions at the different river dune sites at Swifterbant.

	S21-S24		S61	
	Number %	*≥ 3 g*	*Number %*	*≥ 3 g*
Functions	23		3	
Hammer	10	43%		
Anvil	11	48%	2	67%
Grinding	2	9%	1	33%

site S3 in a dominance of anvil and hammer functions over grinding functions. At site S4 the anvils overrule the grinding and the hammer functions. For trenches S21-S24 the high number of hammer tools and anvils is discernible whereas site S51 is remarkably uniform for all functions. Site S61 is the only site where anvil and grinding functions are combined with the total absence of hammer functions.

To sum up, this somewhat complicated calculation emphasises the numerical proportions of the different tool functions. Site S2 is dominated by tools with a grinding function, site S3 by anvil and hammer tools, and site S4 by tools with anvil functions. The dominance of anvils and hammerstones over grinding stones in trenches S21-S24 is overwhelming, and site S51 is evenly spread. The absence of grinding tools (site S41) and hammerstones (S61) may be based on low numbers.

The ornaments form a very small class of artefacts ranging from 0.2% to 4.9%. Because of the generally low number of artefacts at site S61, the one refitted bead forms 11% of the material. The absence of ornaments on site S51 may be the result of the destruction of the site in prehistoric times. More specifically, graves, and consequently a certain amount of (amber) ornaments, may have been present at the site before it was eroded. The creek washed away large parts of the levee limiting the excavations to a peripheral band of clay only. Still, as sites S4 and S61, together with trenches S21-S24, yielded only one or two ornaments, the lack of any ornaments may not even be significant at all.

More important is the relationship between ornaments and cemeteries. Nearly 25% of the stone ornaments were retrieved from burial contexts. The presence of numerous ornaments in the cultural layer of site S3 is, however, exceptional. The handful of ornaments found in the cultural layers of sites S2 and S61 may point towards a similar phenomenon but to a lesser extent.

The few 'other' artefacts are so rare and of such a specific nature that they are not analysed on this level. For details on these finds, please see the artefact descriptions per site in catalogue chapter 1.

In conclusion, sites S2, S3 and S4 are most similar in artefact composition. The high number of debitage material and tools on site S3 point to a more residential character of the site. The presence of the cemeteries on sites S2 and S4 (see sections 2.6.2, 2.6.4, and 2.7.2) may provide an explanation for the different types of activities there. Also, the high number of artefacts < 3 g on site S4 might be an indication of such a different use. And even though sites S2, S3 and S4 are geomorphologically speaking very similar and were covered by clay at roughly the same time, it cannot be ruled out that this high fragmentation rate might be an indication of some sort of taphonomic phenomenon we currently have no grip on. More differences are visible within the debitage material and the toolkit. Site S2 separates itself from the others by its high percentage of chips and its low number of cores. And even though hammerstones and anvils, as well as grinding stones are present on all three sites, the dominance of grinding tools and ground stone fragments on site S2 is discernible. For site S3 these are anvils and hammerstones and for site S4 this is anvils.

Trenches S21-S24 have a rather special position. As mentioned above (see section 4.2.5), there is currently no way of knowing which stone tools belonged to which habitation phase, although a Neolithic origin of most of the stone material may be presumed by analogy with sites S61 and S80-S84[25]. Therefore, the overwhelming dominance of waste material, and the near absence of debi-

25 The low number of grinding stones at trenches S21-S24 may suggest the dominant Mesolithic character of the stone assemblage. However, by analogy with sites S61 and S80-S84, sites of Mesolithic date with hardly any use of stone artefacts, the largest part of the material in trenches S21-S24 may be interpreted as Neolithic. Even more, at site S61 the stone material is nearly exclusively related to the Neolithic occupation layer.

tage material and especially tools, may be the result of the site's function. This also applies to the low number of artefacts < 3 g. Besides being a cemetery, the site shows little trace of being used as special activity zone or residential area. Yet, with the high number of stone fragments, pebbles and cobbles it seems to have had a high storage capacity. Furthermore, the position of the river dune site in the landscape, at the creek nearest to the Vecht system and the boulder clay deposits, may suggest it was used as a storage place for stones, i.e. a raw material cache or depot.

As site S51 is a levee site, one might expect a similar use as sites S2, S3 and S4. Then again, it is located farther downstream the main creek, somewhat isolated from the others. Except for the same percentage of artefacts < 3 g, no indications towards this hypothesis can be substantiated at first sight, as the three main categories of artefacts ≥ 3 g are present in percentages that deviate from those of sites S2, S3 and S4. Yet, the composition per artefact category is similar. As it happens, the debitage material holds the same division in terms of percentage as the three other sites and all three types of tool functions are present.

Finally, site S61 is, with its high number of artefacts < 3 g, as curious as site S4. Debitage at the site is established by the presence of flakes and chips, as well as the use of anvils and grinding tools. Any other form of comparison is impracticable due to the general low number of artefacts.

4.8.2 Tools, ornaments and functions

As no stone material naturally occurs in the soil of the Swifterbant area, all artefacts had to be brought to the site. It is established that the main source is the boulder clay deposits (see section 4.3). These deposits contain boulders, cobbles, and pebbles ranging from several tons to less than a hundred grams, all made out of different types of stone. Yet, the stone artefacts recovered at the Swifterbant sites are limited in their variety of size and type composition which clearly indicates selective collection.

Typical of the cobbles and pebbles from the boulder clay are their round shapes with naturally rolled surfaces. Stone types with a layered structure, in contrast with an amorphous structure, often have a more flat or plate-like appearances but still depict rounded edges. The tools mostly exist of blank cobbles or pebbles that are not altered or modified in any way. Therefore, hand-size rocks that comfortably lie in the hand were primarily chosen as tool blanks. Alternatively, these stones do not need any form of modification; they are ready to use, hence, no time investment is wasted. The pebbles, being smaller than the cobbles, also have rounded or oval shapes. The same applies to the larger cobbles, even those of a few kilograms. It was observed that only a handful of stones weigh between 2 and 4.5 kg. This is most likely related to the weight limitations set by long-distance transportation, ease of handling and possibly functional preconditions.

It was observed that the tools on blank cobbles generally have two basic shapes. The first shape is more cubic or beam shaped, with two flat opposing surfaces and often four sides. The second shape is that of a turned over pyramid. Here the flat surface is opposite to a point, that may or may not be pushed into the ground while used. The pebbles mostly have oval shapes, although some bigger specimens might be angular as well.

Although the raw material could be transported over the creek systems by canoe, the fact that the two creek systems required to travel from Swifterbant to the presumed procurement sites are two separate systems must have placed a certain limit or strain on the supply, at least more strain than when the raw material would have been readily available a few metres from the sites. This strain on the supply of raw material might have urged the Swifterbant people to re-use tools. Although one might wonder if with c. 200 kg of stone artefacts other than flint there was any strain at all. The re-used tools are 'old' tools, discarded or not, and fragments thereof. Furthermore, the re-used tools may have been used for a different activity once they were broken and no longer met the requirements for the first activity. Thus, the first use of the tool is not always identical to its second use.

At nearly all sites the tools are the artefact type most often exposed to heat. This is especially so for site S2 and S3 where 27% and 21% of the tools show signs of heat damage. For site S4 this is 6% which is still the largest amount of all artefact types. The low numbers of heat exposed artefacts at sites S51 and S61 do not result in representative percentages, neither do the artefact categories in trenches S21-S24 (also see section 3.6.10).

Hammerstones

A total of 21 hammerstones were retrieved from sites S2, S3, S4 and trenches S21-24. These are predominantly made from different types of sandstones and quartzites (76%), less often from granite or gneiss (14%) or porphyry (10%). This preference for different types of sandstones and quartzites is seen on all sites. Even more, it is in accordance with the use of hammerstones for flint production (Callahan 1987: 45-46, Drenth & Kars 1990, Hahn 1991, Semenov 1964).

The tools have percussion marks on one or more extremities, faces and/or sides, or may be used all around. Both pebbles and cobbles were employed. The complete hammerstones produced on the first type of blanks weigh between roughly 30 g and 100 g. The weights of those on cobbles range from approximately 200 g to 300

Table 4.13 Different weight classes per tool type.

	number of tools	weight class 1			weight class 2			weight class 3			weight class 4		
			n	%		*n*	%		*n*	%		*n*	%
Hammer-stones	10	30 - 100 g	7	70%	200 - 300 g	3	30%						
Anvils	16	100 - 300 g	12	75%	450 g	2	12.5%	700 - 800 g	2	12.5%			
Handstones	9	60 - 200 g	8	89%	350 g	1	11%						
Netherstones	1	3000 g	1	100%									
Combination tools	73	50 - 400 g	50	69%	500 - 900 g	12	16%	1200 - 1500 g	9	12%	4400 g	2	3%
Ha. / An.	45	50 - 400 g	39	87%	500 - 600 g	4	9%	1400 g	1	2%	4400 g	1	2%
Ha. / Gr.	8	30 - 80 g	4	50%	400 g	1	12.5%	800 - 1200 g	3	37.5%			
An. / Gr.	9	70 g	1	11%	300 g	2	22%	600 - 1500 g	5	56%	4400 g	1	11%
Ha. / An. / Gr.	11	60 - 400 g	6	55%	500 - 900 g	5	45%						

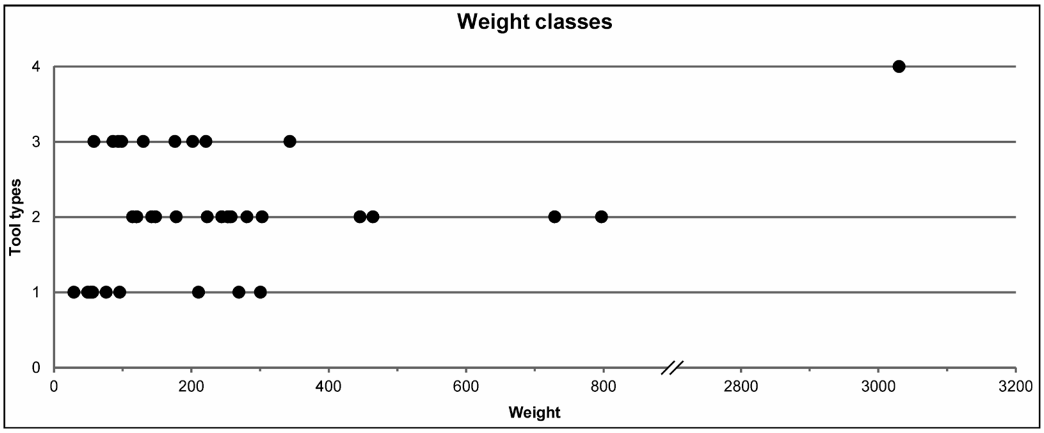

Figure 4.38 Visual representation of the different weight classes per tool type (single function tools). Key: 1: hammerstones, 2: anvils, 3: grinding stones (handstones), 4: grinding stones (netherstones).

g (table 4.13 and figure 4.38)[26]. A hammerstone produced on an old cobble fragment weighs 76.3 g and therefore falls within the weight range of the pebbles. The weight range of 200 g to 300 g perfectly matches with the knapping experiments by Pirnay (1981) and is similar to the hammerstones used by Marshall (Barlow & Mithen 2000). Pirnay used sandstone pebbles of 200 g to 300 g because these are a balance between the hammerstone's weight, the nature of the raw material, and the force of impact needed to knap flint. The antler percussion tools used by Pirnay weigh for example 400 g.

This dichotomy between the two weight groups is explained as difference in function, a group of heavy-weight hammerstones for heavy duties (*hammerstones* for opening nodules and debitage) and a group of light-weight tools for lighter work (*retouchoirs* for platform preparation and retouching). For instance, Pirnay (1981: 15) used a hammerstone weighing 1 kg to fracture very large nodules and cobbles. Marshall also experienced that certain types and weights of hammerstones were better suited for certain aspects of flint debitage (Barlow & Mithen 2000: 518). The different intensities of the impact traces point to this as well. The measurements of the two different weight groups range from 36x29x13 mm to 93x39x35 mm and from 71x52x26 mm to 88x71x54 mm Thus, as these two groups intermingle it must be the weight that is of primary importance for the selection of the function of a hammer tool.

The nature of the contact material is also responsible for the magnitude of the percussion or impact marks. Stone or flint debitage, roughening of grinding stones, and pounding of temper will leave other marks than cracking

26 For the analysis of the different weight classes of the stone tools only complete and undamaged specimens were chosen. These were plotted in a graph whereby certain weight clusters would present themselves. These weight classes are used in this analysis, thus not presupposed weight classes.

nuts, squashing seeds, or processing plants or herbs. The force of impact is also of relevance here.

Anvils

Sites S2, S3, S4, S51, S61 and trenches S21-S24 yielded a total of 34 anvils. For the production of these tools different types of sandstones and quartzites (53%) were preferred. Less often used was granite or gneiss (35%) whereas porphyry (10%) and amphibolite (3%) were used rarely. Thus the choice of raw material type is less restricted and less dominated by different types of sandstones and quartzites than with the hammerstones. The dominance of sandstones and quartzites is clearly observed at sites S3 and S4; sites S2, S51 and S61 have low numbers blurring the image.

All these artefacts have one to three areas with grouped impact traces located in the middle of the surface, sometimes in combination with a shallow pit. Mainly cobbles, or fragments thereof, were employed as blanks; indeterminate fragments were used to a lesser extent. The complete anvils' weights predominantly range between c. 100 g and 300 g; two weigh around 450 g, and the remaining two between 700 g and 800 g (table 4.13 and figure 4.38). It is mainly the anvils produced out of indeterminate fragments that weigh the least. Not only the weight suggests a wide variety of blanks; the general shape and measurements also indicate this. The minimum measurements are 55x44x25 mm while the maximum measurements are 117x86x77 mm.

It was observed that the intensity of the impact traces, as well as the shallowness or deepness of the pits, may differ per artefact. Varying amounts of impact force, possibly together with different weights and sizes of the contact material, have resulted in this. The nature of the contact material itself, being stone, wood, bone or any other material, must also have had an effect on the intensity of the impact traces. A number of pits are rather deep, creating some resemblance to mortars. Therefore, it is believed that the anvils were not only used for working with flint, either for support during retouching or during bipolar debitage, but also for pounding temper and processing food like cracking nuts or soften certain plants.

Grinding stones

The 44 handstones and 8 netherstones were recovered at sites S2, S3, S4 and S51. The combination of a handstone with a netherstone makes a grinding tool complete. As the two tool types are separate from each other, it is not possible to establish which handstone was used on which netherstone making it impossible to define specific grinding tools. One combination might be confirmed by their proximity in situ (see catalogue section 1.2.4). Different types of sandstones and quartzites (44%) and granites or gneisses (35%) are mainly used for the production of both types of grinding stones. Porphyry (6%) and leptite (4%) are selectively chosen for handstones and netherstone respectively. All other stone types, comprising diorite, gabbro, basalt, helleflint, amphibolite, and schist are represented by only one handstone each. Amongst these handheld tools, the polishers, only made from quartzitic sandstone, make up 7%. The numerical superiority of the handstones presumably determines the variety of stone types. With so many different raw materials the variety of stone types is even wider than with the anvils. The dominance of different types of sandstones and quartzites may be somewhat unexpected as granites and gneisses are more abrasive. Still, this was observed at all sites, except on site S3 where the number of granites and gneisses equals that of the sandstone and quartzites. The compactness of quartzitic sandstones and quartzites results in a lesser loss of crystals and minerals during usage, hence results in a better quality of processed food.

Smoothed to polished patches, and sometimes larger areas, occur on one or two surfaces. These two working areas are mostly located opposite each other, one on the upper surface, and the other on the lower surface of the tool. In one case up to three surfaces were covered with gloss or polish. When multiple surfaces with smoothing or grinding traces occur, these are always of a different intensity as if one surface was used more intensely than the other. A difference in intensity is also observed between grinding stones and polishers. The traces on the latter are less developed suggesting a different or less intense use. The grinding surface of the handstones is mostly flat and sometimes lightly convex, whereas the working surface of the netherstones is also mostly flat and rarely concave. It was observed that a few handstones, like the one from the grinding tool found on site S4 (*no. G92-03561-1*) have a convex working surface with a deep pit in the middle. One might interpret this pit as an anvil pit but it would also be convenient when grinding food or grain. The cereal would be 'captured' in the pit instead of being pushed to the sides on the flat surface of the netherstone. The Neolithic saddle querns avoid this problem by having a pronounced concave surface.

The range of weight of the two tool types is very hard to establish as most grinding stones are fragmented. Still, the few complete handstones weigh between roughly 60 g and 200 g (table 4.13 and figure 4.38) and measure between 47x39x25 mm and 77x63x44 mm. Only one is larger weighing c. 350 g (79x59x41 mm) whereas the smallest dimensions and weight come from a grinding stone produced on a pebble which therefore may very well be a polisher. The only complete netherstone weighs approximately 3000 g and has dimensions of 218x181x59 mm. The fragmentation of the grinding stones is most often the result of deliberate pounding on the edges. Whether this is intentional debitage in order to produce flakes, or is the deliberate destruction of the tools is not entirely clear. The numerous ground stone fragments at least confirm the process. Roughening may lead to fracturing as well, although fractures are then mostly initiated in the middle of the surface where the working area is totally smoothed or polished losing its abrasive character.

The varying use intensity of the surfaces, i.e. the upper surface versus the lower surface of one tool, is not only confirmed by use-wear analysis, it is also attested in other research (Verbaas 2005, Verbaas & van Gijn 2007). One of the explanations is that the surface on which the netherstone is resting during use would also create friction. As this friction is limited this would result in lighter wear-traces. More or less wear as a result of different intensities, for example when a stone is used at both surfaces, or different types of contact material may be put forward as well. Furthermore, directionality in the traces is also established, both in longitudinal direction as in multiple directions, and even in accordance with the bedding of the raw material. However, these use-wear traces could not reveal the nature of the contact material. Still, the size of a handstone might give some indication of the activity it was used for. One might imagine that the use of a small pebble as grinding tool for large amounts of seeds or grains is rather ineffective. On the other hand, such a small tool might be useful to polish pottery or rub hides.

Residue analysis can provide more information on the possible function of a tool. All analysed grinding stones contained phytoliths in more or lesser amounts. It was observed that netherstones often hold more of these microfossils than handstones. The amount of phytoliths present on the different surfaces of the same tool, i.e. the upper surface versus the lower surface, may be equal but may differ as well. Even more, the number of microfossils seems to rise with the intensity of the usage of the tool. When processing plant material, phytoliths are pushed into the cracks of the tool's surface. The phytoliths become fragmented and accumulate during intense usage. However, phytoliths were also detected on a surface that was not smoothed. First of all, an artefact can be used without leaving any visible use-wear traces; secondly, the presence of phytoliths on an 'un-used' surface may be the result of contamination. The analysis of the soil samples revealed that phytoliths are present in the soil in large numbers, and thus may penetrate the artefact's surface while in situ. Yet, their undamaged state may set them apart from phytoliths worked into the surface.

Due to the highly fragmentary state of the phytoliths, it could not be discerned whether they were from wild grasses or domesticated grains. Yet, all the phytoliths are alike indicating the processing of similar plants for both the handstones and the netherstones of the different sites. Even the analysed soil samples, which are richer in phytoliths and show a far lesser state of fragmentation thereof, could not determine the exact nature of the plants. Thus, evidence of processing different kinds of grasses and maybe of early cultivars is suggested.

The 103 ground stone fragments were collected at the same four sites. Again, the dominance of different types of sandstones and quartzites (51%) together with granites or gneisses (34%) is attested. Porphyry (8%) and helleflint (4%) are used less often whereas gabbro, basalt, and leptite occur once. This large variety of stone types perfectly fits with that of the hand- and netherstones. Sandstone and quartzite dominance is seen for the ground stone fragments on sites S3 and S51, and that of granite and gneiss on sites S2 and S4, which is somewhat different from the hand- and netherstones.

These chips, flakes and indeterminate fragments with traces of smoothing or polish form a wide group of all sorts and sizes. Their weight ranges between 0.2 g and 450 g while their measurements vary from 6x10x2 mm to 138x86x53 mm.

These numerous ground stone fragments illustrate the high fragmentation rate of the grinding tools. By themselves, grinding tools are roughly 2 to 4 times as often fragmented as the other tool types. When the ground stone fragments are included, their fragmentation rate reaches as high as 90% or 5 times as high as some of the other tool types. This particular treatment of grinding stones, i.e. their deliberate fragmentation, may indicate their special connotation. Besides all sorts of functional explanations, deliberate destruction as some form of ritual destruction, maybe at settlement abandonment or at the end of the artefact's life, must be considered. The deliberate destruction of (high value) objects has been observed on different occasions (Chapman 2000, Larsson 2000 and 2004, Verbaas & van Gijn 2007, Wentink 2006). It is also possible the grinding stones were seen as Neolithic icons, symbols of the new economy or subsistence of cultivating cereals (Devriendt 2008a). Even after generations, their intrinsic value may have been higher than that of hammerstones or anvils, inheritance tools of the Mesolithic.

Combination tools

These artefacts are all multifunctional tools like Swiss Army knives. The combination of two or three functionally different aspects of the tools makes them highly utilitarian and compact. Their characteristic features correspond to the features of the 'single activity' tools; the same basic shapes and working areas occur. This also applies to the conducted activities, as proven by use-wear and residue analyses, and the choice of raw material (see below). All this illustrates the same selective method of acquiring tool blanks.

But the whole is more than the sum of its parts. For example, the handstone of the grinding tool retrieved from site S4 (no. 151, pl. 30) is interpreted as a 'triple' combination tool. The pit in the middle of the grinding surface is seen as an anvil pit. But it is also possible that this rather large pit is some sort of hollow to keep the seeds or grains restrained during the grinding process. Therefore, these multifunctional tools may be more functional, practical, and user-friendly than their 'single' tool counterparts.

Table 4.14 Number of combination tools per site.

	S2		S3		S4		S21-S24		S41		S51		S61		Total	
Ha. / An.	2	40%	59	64%	7	58%	4	80%	1	100%	2	67%			75	63%
Ha. / Gr.	2	40%	13	14%	1	8%					1	33%			17	14%
An. / Gr.	1	20%	8	9%	3	25%							1	100%	13	11%
Ha. / An. / Gr.			12	13%	1	8%	1	20%							14	12%
Total	5	100%	92	100%	12	100%	5	100%	1	100%	3	100%	1	100%	119	100%

Ha. / An. (hammerstone / anvil combination), Ha. / Gr. (hammerstone / grinding stone combination), An. / Gr. (anvil / grinding stone combination), Ha. / An. / Gr. (hammerstone / anvil / grinding stone combination).

The possibility that combination tools are actually nothing more than the accumulation of separate activity events or single activity tools cannot be ruled out when traces are spatially separated from each other. Traces that overlap show a certain sequence of events, yet give no real indication of the time depth of these activities. Even re-used tools, indicated by fracturing and the re-appliance of working surfaces, give no actual time depth of the first use compared to the second.

The 119 combination tools are defined as 75 hammerstone / anvil combinations, 17 hammerstone / grinding stone combinations, 13 anvil / grinding stone combinations, and 14 hammerstone / anvil / grinding stone combinations (table 4.14). Most types occur on sites S2, S3 and S4 whereas sites S41, S51 and S61, together with trenches S21-S24 yielded only a handful of combinations tools.

For all tool types the dominance of different types of sandstones and quartzites is observed, always in combination with granites or gneisses, although their mutual percentages may differ per tool type. Porphyry and amphibolite occur rarely. The mutual percentages for the quartzites and granites / gneisses are always largely in favour of the different types of quartzite when the tools have a hammer function (table 4.15). The preference of quartzites for single activity hammerstones (76%) thus seems to continue for the double and triple activity tool types. The higher value of granites and gneisses only seems to apply on the anvil / grinding stone combinations. As this was also observed for the single activity tools (35%) this is possibly a real trend and not so much influenced by the relatively low number of tools. Yet, this should be monitored more carefully in the future, when more stone assemblages have been analysed in detail.

Table 4.15 Percentage of tools per raw material class.

	G / G	S / Q	Other
Ha.	14%	76%	10%
An.	35%	53%	12%
Gr.	35%	44%	21%
Ha. / An.	23%	75%	2%
Ha. / Gr.	18%	76%	6%
An. / Gr.	54%	38%	8%
Ha. / An. / Gr.	14%	86%	

G / G: granites and gneisses, S / Q: different types of sandstones and quartzites.

Weights are first analysed per tool type, then an overall image is sketched for all types together (table 4.13 and figure 4.39). As the hammerstone / anvil combinations are most numerous, this type provides the best overall image. The weight of 39 complete tools gradually increases from small pebbles weighing roughly 50 g to cobbles weighing 400 g, four tools range between 500 g and 600 g, and the final two roughly weigh 1400 g and 4400 g. The contrast between the pebbles and the cobbles is more clearly cut for the hammerstone / grinding stone combinations. Most intact tools range between 30 g and 80 g, one tool weighs around 400 g, and the final three weigh between 800 g and 1200 g. Of the anvil / grinding stone combinations one tool weighs c. 70 g, two weigh roughly 300 g, whereas the largest group weighs between 600 g and 1500 g, and a final tool weighs 4400 g. Roughly half of the hammerstone / anvil / grinding stone combinations weigh between 60 g and 400 g, the other half between 500 g and 900 g.

These four categories of tool types fall within the same general picture. Up to 72% of the tools range from c. 50 g to c. 400 g, 18% weigh between c. 500 g and c. 900 g, 12% between c. 1200 g and c. 1500 g, and 3%, which are only two tools, weigh c. 4400 g. The corresponding minimum and maximum measurements are for the first weight class 41x32x16 mm and 109x84x58 mm, for the second 78x64x43 mm and 130x101x70 mm, for the third 114x88x55 mm and 160x125x90 mm, and the final tool measures 186x133x111 mm.

Polished axes

The 20 axes and axe fragments are unevenly spread over the different Swifterbant sites (table 4.16). Sites S3 and S4 have ten and five artefacts respectively, whereas site S2 has only two. Sites S41 and S51, together with trench

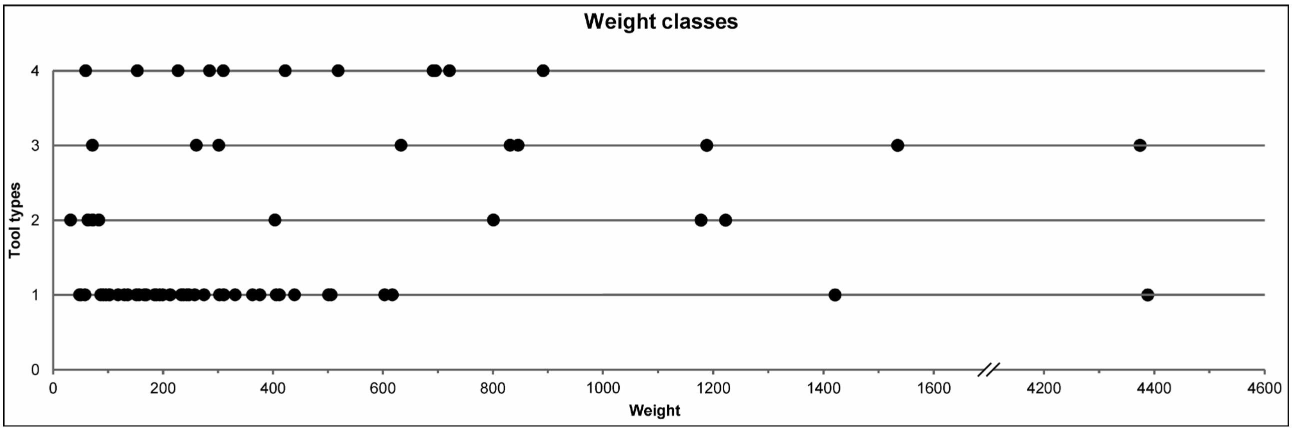

Figure 4.39 Visual representation of the different weight classes per tool type (combination tools). Key: 1: hammerstone / anvil, 2: hammerstone / grinding stone, 3: anvil / grinding stone, 4 hammerstone / anvil / grinding stone.

Table 4.16 Overview of the axes and axe fragments at the different sites.

Site	Type	Raw material	Origin
S2	Fragmented axe (hourglass perforation)	Quartzitic sandstone	Northern
S2	Cutting edge of an axe	Quartzite	Northern
S3	Axe with oval cross-section	Quartzite	Indeterminate
S3	Axe with oval cross-section	Diabase	Southern
S3	Axe with oval cross-section	Quartzitic sandstone	Indeterminate
S3	Shaft-hole axe fragment	Amphibolite	Southern
S3	Shaft-hole axe fragment	Amphibolite	Southern
S3	Fragmented axe (hourglass perforation, tilted cutting edge)	Porphyry	Northern
S3	Fragmented axe (hourglass perforation, tilted cutting edge)	Porphyry	Northern
S3	Fragmented axe (hourglass perforation) weathered	Gneiss	Northern
S3	Axe fragment (hourglass perforation) refit S41	Quartzite	Northern
S3	Axe fragment, group S4	Diabase	Southern
S4	Axe fragment	Diabase	Southern
S4	Axe fragment	Diabase	Southern
S4	Axe fragment	Diabase	Southern
S4	Axe fragment	Diabase	Southern
S4	Flake from axe	Quartzite	Northern
S22	Flake from axe	Amphibolite	Indeterminate
S41	Axe fragment (hourglass perforation) refit S3	Quartzite	Northern
S51	Blade from axe	Quartzite	Southern

S22 have one artefact each; sites S61 and S80-S84 had no fragments at all. As certain fragments fit together, the current number of artefacts does not correspond with the original number of axes. From site S2 a fragmented axe with an hourglass perforation and an axe fragment were recovered[27]. The latter is made out of the same stone type as a fragment from site S3 and S41. They all might originally have come from the same boulder or cobble but are presumably not from the same axe. Site S3 is characterised by three axes with oval cross section, a shaft-hole axe fragment existing of two fitting pieces, two fragmented axes with hourglass perforation and a tilted cutting edge, one weathered fragmented axe with hourglass perforation, an axe fragment with hourglass perforation that is a fit with the fragment from site S41, and a small axe fragment belonging to the group of fragments found on site S4. As the largest part of the refit between the S3 and S41 fragments was found on site S3, the axe is allocated to site S3. The same applies to the fragment belonging to the group

27 The site also revealed an axe with oval cross section from a Bell Beaker context.

of site S4 that is counted as a piece of that group. Thus, five fragments of the same axe are designated to site S4 being two axe fragments that fit together, two more fragments produced from identically the same raw material, and the fragment found on site S3. One more artefact was retrieved from site S4, which is a flake of a different axe. Another flake was found in trench S22, and site S51 revealed the blade-like fragment.

To sum up, the original count of the axes will be given per site and their raw material will be divided by origin. Site S2 held two different axes produced out of a stone type with northern origin (boulder clay deposits or Scandinavia). On site S3 eight different axes, that includes the fragment of site S41, must have been present. Based on the raw material, the shaft-hole axe is of (south) eastern origin, just as one of the axes with oval cross section. The three fragmented axes with hourglass perforation are of northern or local origin, just as the refit between the fragment of site S3 and the one from site S41. The two remaining oval axes could both be of northern or southern origin, just as the single axe fragment of trench S22. Site S4 held two axes, including the fragment of site S3, of which one is of (south) eastern origin and the other is of northern origin. The axe fragment from site S51 is of southern origin.

The shaft-hole axe with straight or lightly conical perforation is an import from the farming communities in the southeast (Rössen or one of its descendants) (see section 3.2.6). The four axes with an hourglass perforation are all made from a northern raw material type and are defined as local products or copies of shaft-hole axes. Local copies of shoe-last axes are also found in Scandinavia and northern Germany. These local productions are characterised by their raw material and the orientation of the shaft-hole parallel to the layers of rock, not vertical as they should be (Klassen & Jonsson 1999). Specimens of Mesolithic date have biconical perforations made by pecking (Fischer 2002), whereas Neolithic specimens often have conical perforations (Klassen & Jonsson 1999). A well-known local copy of a shaft-hole axe is the specimen from Ringkloster (Andersen 1998) although more remarkable specimens with a conical and an hourglass perforation are known from Denmark and Germany (Klassen & Jonsson 1999), and even from the Netherlands (Brounen 1997). These local copies are characterised by their large morphological variability, not one is the same. Two of the specimens from Swifterbant stand out because of their tilted cutting edge. It appears that the lack of modelling, as seen with hammerstones and other tool types, also holds for these two axes. A stone of adequate shape and measurements is altered in a minor way, as only a cutting edge and perforation were applied. The tilted cutting edge observed on the first tool might be the result of using a naturally shaped rock. On the other hand, the second specimen showing a tilted cutting edge seems more elaborately worked. The suggestion that the tilted cutting edge would make the tool unusable is rejected as use-wear analysis clearly established the presence of wear traces on these tools.

The axes with oval cross section, thus without perforation, have a Neolithic date and are often related to the Rössen and Michelsberg culture (Brandt 1967, Schut 1991), they were even still in circulation during the TRB (Bakker 1979, Hoof 1970). The raw material types of the specimens at Swifterbant suggest a southern origin; although a northern origin of one of them cannot be ruled out.

This research illustrates that the axes found at Swifterbant are perfectly usable tools; even the two perforated axes with a tilted cutting edge are usable specimens (see section 4.5.3). Although the use-wear analysis of the axe fragments revealed little information, the friction gloss in the perforation and use polish on both cutting edges confirmed that these tools have been used. However, the raw material type prevented the determination of the contact material. Thus, even with a tilted cutting edge, the local copies of Rössen shaft-hole axes are perfectly usable tools. One of the possible activities for shaft-hole axes, or any other type of sharp edged axe for that matter, is wood working (see section 3.2.6). Yet, at Swifterbant the use as 'wood axe' could not be corroborated by use-wear analysis. Even more, as one of the axes with oval cross section has impact traces on its butt, it may have been used as some sort of wedge, also possibly during wood working.

Ornaments

A total of 108 ornaments, or fragments thereof, have been found on five different sites (table 4.17). When animal teeth and bone ornaments are excluded, 89 pieces remain. Of these 61 are made of amber and 28 of different types of stone.

The ornaments are 36 pendants, of which 20 are unfinished, together with 25 beads, 20 pendant or bead fragments, and 8 chips of amber, found on sites S2, S3, S4, S61, and in trench S22. Besides the 8 chips, 53 ornaments are made of amber (69%), the remaining 28 ornaments (31%) are of different types of stone such as sandstone (13), quartzitic sandstone (9), shale (2), quartzite (1), quartz (1), radiolarian rock (1), and jet (1). The amber ornaments are of northern origin, whereas the stone artefacts are most, if not all, of southern origin. The low specific weight of amber means that most of the complete artefacts weigh between less than 0.1 g and 1.1 g. The four ornaments that are the exception, weighing between 4.5 g and 7.3 g, all come from the male grave IX on site S2. The minimum and maximum measurements for the first group are 6x5x2 mm and 17x13x12 mm, those of the second group are 25x19x14 mm and 37x23x19 mm. The weight of the complete stone ornaments gradually increases from 0.6

Table 4.17 Number and type of ornaments found at the different sites at Swifterbant.

Site	Number	Pendant			Unfinished pendant	Bead			Fragment		Chip
		A	S	T	S	A	S	B	A	S	A
S2 CL	**9**				3	2	1		3		
S2 GC	**18**	5	1	1		9			2		
S3 CL	**76**	4	4	17	17	12		1	13	1	7
S4 GC	**1**	1									
S22 GC	**1**		1								
S61 CL	**3**								2		1
Total	**108**	**10**	**6**	**18**	**20**	**23**	**1**	**1**	**20**	**1**	**8**

CL: cultural layer, GC: grave context, A: amber, S: stone, B: bone, T: animal tooth.

g to 20 g. However, the ornaments weighing between 10 g and 20 g are far less numerous as they only represent 25% of the complete stone ornaments. The measurements range from 15x11x2 mm to 50x32x16 mm.

The techniques used to make the amber, or stone, ornaments at Swifterbant are very limited. No evidence of shaping the amber lumps has been found, in contrast to the amber finds in Scandinavia that are perforated, worked, polished or even decorated (Mathiassen 1960). The animal figurines are possibly the best known examples (Larsson 2001, Mathiassen 1952). The reason for this lack of shaping is probably the smaller size and the fact that amber is far less available in the Netherlands. Also, the natural shape and size of the amber lumps and flat stone pebbles may have been decisive in the location of the perforation. A hole was made with a flint borer resulting in an hourglass shaped perforation. According the shape and size of the lump or stone, this perforation was set either at the edge or in the middle of the artefact transforming it into a pendant or a bead.

Almost all ornaments have hourglass shaped perforations with outer diameters of 1-2 mm to 4-5 mm, whereas 6-7 mm is rare and 10 mm occurs only once on an amber pendant. The inner diameters of the perforations on amber ornaments vary from 2 to 4.5 mm while those of stone ornaments range between 1 and 2.5 mm, and only once reaches 3-4 mm. The perforations of the amber ornaments are set at 1 mm to 2.5 mm from the edge with 4 to 7 mm as exceptions occurring only once. The perforations in the stone ornaments are mostly set between 2 and 6 mm from the edge, locations at 0.5-1.5 mm or 7-8 mm are exceptions. The unfinished pendants have little pits of mostly 1-2 mm deep, seldom 3 mm. Thus, the perforations of the amber ornaments are set more closely to the edge, possibly as a result of the limited size of the objects, whereas outer diameters of the perforations are roughly the same. The inner diameters of amber ornaments are larger than those of the stone pendants which might be related to the softness of the material, i.e. the wearing out of perforations, the duration of use, or a somewhat different perforation technique. As the amber ornaments were probably not produced at the site, and the stone ornaments were, a difference in technique or perforation device is likely. As the flint borers, found on sites S2, S3, S4, S41 and trenches S21-S24, have tips measuring from 3 mm up to 4-5 mm, these were presumably not used or could no longer be used to perforate ornaments. But the striations in the holes of the stone and flint pendants prove that flint borers were used. Furthermore, the presence of the right types of raw material[28] in the shape of unaltered flat pebbles, unfinished as well as finished stone ornaments, together with broken or discarded pendants and beads, confirm ornament production at sites S2 and S3, and maybe at site S4 as well, suggesting that the sites were inhabited long enough to manufacture, discard, and lose the ornaments. Thus the sites were inhabited, presumably by complete households, over an extended period of time.

The absence of unaltered amber lumps and unfinished amber pendants or beads is interpreted as evidence of import of fully manufactured amber ornaments (see Devriendt 2008c). Another argument for import is the difficulty of perforating amber, a procedure which often results in the breakage of the ornament (Piena & Drenth 2001). As no amber ornaments at the Swifterbant sites show any sign of being broken during perforation, it is believed they are brought to the sites in finished condition. However, this import theory has come somewhat under pressure as the experimental research of Verschoof (2008) proved that perforating amber is quite easy and

28 These types are sandstone, quartzitic sandstone, quartzite, quartz, and radiolarian rock but not jet or shale, implying the three ornaments produced out of these two types of raw material were imported.

does not necessarily lead to fragmentation. This indicates that successful perforations may be a reflection of the individually bound skills and the level of experience of the person performing the experiment. This brings up the possibility that the amber ornaments may have been produced at the sites in Swifterbant. Still, it leaves the lack of amber raw material unexplained. Alternatively, the high value of amber might have resulted in the perforation, and use, of all amber pieces on the site.

This argument can also be put forward for the perforation of pendants made out of animal teeth. As no unfinished pendants made out of teeth are retrieved at the sites, it is my opinion that they too are imported products. Yet, Prummel states (pers. comm. 2008) that the ease of perforation would only result in finished pendants and not necessarily in fragmented or unfinished products. The presence of many unaltered animal teeth at the Swifterbant sites may support Prummel's vision. Then again, they can also be interpreted as butchery waste.

Most of the ornaments have been retrieved from the cultural layer of site S3. The production, discard, and loss of ornaments during the occupation of a certain area is to be expected. Yet, the magnitude of the occurrence at site S3, as compared to sites S2 and S61, is to me somewhat unsettling. With 36 out of 53, this would mean that nearly 70% of the amber ornaments were either lost or discarded, or were just left lying around, 81% of these at site S3. This suggests that the occupation at site S3 is of a longer duration or larger magnitude than was first imagined. It also implies that the Swifterbant people did not value their amber ornaments as highly as we think they did, or at least treated them differently than we currently do with our highly valued items.

The relation between ornaments and cemeteries has been established at three sites. Up to 23% of the ornaments were retrieved from burial contexts. The number of ornaments, and other grave goods, may have been more numerous if organic material had been better preserved.

In the past, these ornaments have been described as grave goods (Meiklejohn & Constandse-Westermann 1978, Constandse-Westermann & Meiklejohn 1979) but as Knutsson (1999: 65) rightly suggested "what we regard as grave gifts are only the whole or a part of the personal belongings of the deceased". The ornaments most likely will have been the personal belongings of the people who wore them and were buried with them. The example can be put forward of the pendant in the child's grave showing few traces of wear whereas the pendants worn by the adult male in grave IX show the heaviest traces of wear at all the sites of Swifterbant. The inner diameter of 4 to 4.5 mm is so exceptional that the ornaments must have been worn over a long period of time; an aspect clearly indicated by the elongated shape of the perforations. The heaviness of the objects would also have contributed to the heavy wear traces.

Personal ornaments may reflect social identity, including the sex, the age or 'the profession' of the wearer[29], social status or wealth (Newell et al. 1990, Taffinder 1998). Taffinder (1998) sees a clear correlation between status-indicators and the exotic origin of the raw material from which they are made. She also states that the study of the ethnographic sources has shown that certain forms of adornment were often reserved for specific occasions rather than for particular age grades or professions. Even more, it may be observed that pendants and beads are most often worn around the head, neck and ears, most likely to maximise visibility. At Swifterbant this could also be observed.

It is hard to pronounce upon the differences between the age or sex groups at Swifterbant due to the limited number of graves and grave contexts found. However, it appears that the largest pendants and beads were buried with the man in grave IX; his ornaments were also the most diverse in raw material types. One of the women was buried with more ornaments than the man, yet of one raw material type only. The other woman was buried with one, presumably imported, jet pendant. As this is the only jet artefact found at the site its significance may not be underestimated. If the ornaments represent social or even ethnic identity, this woman might be of 'southern' origin, as jet is more often found in the middle of the Netherlands, whereas amber is more often found on the coast in the northern half of the Netherlands. These grave goods suggest some social differences or at least point to the presence and importance of personal belongings from childhood onwards as women, men and children were buried with them.

Most of the ornaments are made of non-local materials such as amber, jet, and shale, but also from certain types of flat pebbles. The presence of amber, or any other type of non-local raw material, does not necessarily need to imply the import of these materials, it merely indicates external contacts (van Gijn 2006). Whether these external contacts are in the form of special expeditions intended to procure the material, and are thus a reflection of the mobility area, or whether this is in the form of (gift-) exchange with neighbouring groups, is yet to be established. The current research, however, suggests that at Swifterbant amber, jet, and shale are most likely finished imported products, whereas stone pebbles were presumably gathered personally.

Amber ornaments and figurines have been known from the Upper Palaeolithic onwards, for example at Meiendorf (Rust 1962), and occur over the whole of

29 With 'profession' the shaman, medicine man or other ritual officers are meant.

Northwest Europe. They are known from Mesolithic contexts in England like Star Carr (Clark 1954) but also from Maglemose, Kongemose, and Ertebølle sites in southern Scandinavia (Larsson 2001). In the Netherlands pieces of amber are known from various Hamburg sites like Ureterp and Vledder (Bohmers 1947, De Laet & Glasbergen 1959) but not from Mesolithic contexts (Waterbolk & Waterbolk 1991: 203, Newell et al. 1990: 99).

Amber grave goods are known from a number of sites in southern Scandinavia like Vedbaek, Nederst and Skateholm (Kannegaard Nielsen 1990, Larsson 2001). At Skateholm I at least one adult and a child were buried with rich gifts of animal teeth and pieces of amber. Some pieces of amber were perforated and measure up to 6 cm (Larsson 2001). Yet, all in all amber ornaments in graves are rather rare. Mostly animal teeth of various species are used, like deer, wild boar, dog, bear, elk, horse, or even seal and beaver, whereas shells, bones, and different kinds of stone occur occasionally (Grünberg 2000). In the Netherlands amber in graves are known from Urk, Schipluiden, Ypenburg, and from the megalithic tombs of the TRB culture. The amber ornaments in the graves at Swifterbant are thus the oldest in the Netherlands, in the absence of finds contexts from the Mesolithic such as seen in Scandinavia.

In conclusion, the presence of the numerous unfinished stone pendants and the total lack of unfinished amber or animal teeth pendants, supports the idea that amber and animal teeth ornaments were imported to the sites as finished products. However, this does not immediately need to imply long distance transportation. Stone ornament production is clearly demonstrated at sites S2, S3, and possibly site S4. Ornaments of jet and shale may however have been imported. The local production of stone ornaments proves prolonged periods of habitation as ornaments are made, worn, discarded, lost, and buried with the deceased at the sites. The ornaments are seen as the personal belongings of the wearer, possibly as an indicator of social identity, status or wealth or maybe even ethnicity.

Other artefacts and activities

There are seven dissimilar artefacts which have in common that their function is unknown. A possible explanation for what they were used for, can however be deduced from some of their features.

It has been argued that the stone with two indentations recovered at site S2 might be a net sinker or net weight. By analogy with objects from Emmeloord the artefact may even be a weight to hold down fish traps.

The discus shaped artefact from site S3 may possibly be a hammerstone as impact traces are visible on its rim. These may also be the result of debitage, as many flakes have been detached, or may point to another, unknown function as well. Its resemblance to an artefact found at Kolhorn is striking (Drenth & Kars 1990). The artefact at Kolhorn is somewhat smaller, c. 5 cm instead of 7 cm, yet of the same stone type. The artefact is flat and almost circular showing bifacial flake scars virtually all around. One area is rather thin, possibly due to the detachment of a large flake, resulting in the definition of a cutting edge (ibid: 31). Unfortunately, the authors could also not come to a conclusion as to the function of the artefact.

Besides proof of Mesolithic habitation, the mace-head of trench S22 is possibly a net sinker, a hammerstone, a club-head, a weight of a digging stick, or even part of a bola (Broadbent 1975-1977, Gramsch 2000, Niekus & Drenth 2008, 2010). Its estimated weight of 1500 g is presumably rather heavy for a mace-head since the smallest diameter of the perforation is limited to c. 22 mm. Its position at the top of a wooden stick is therefore unlikely. However, perforations of shaft-hole axes are often limited as well and these have been interpreted as axes.

Of the remaining artefacts no possible function can be given as the conical object from trench S23 is presumably a naturally shaped object and because the original shape of the three amounts of *Steinbrösel* found at site S3 can no longer be reconstructed.

Functions and activities

One of the clearest indications of specific activities at a site is the presence of certain tool types. The recovered stone tool types are mainly hammerstones, anvils, and grinding stones. These tools may represent many different functions. Hammerstones, often in combination with anvils, may be used for flint knapping, the roughening of grinding stones, the production of temper, and the processing of food and maybe even of colourants or other mineral substances. Grinding stones may also be used for processing food, but also for polishing axes or other types of artefacts like bone awls while smaller pebbles and cobbles may be used for polishing pottery or processing hides.

Another tool type represented by quite a few pieces is the axe. The axe, perforated or not, is often related to different kinds of wood working, even felling trees. Also debitage may point is this direction (see below). Hollowing out a canoe is preferably done with an adze or chisel. As these tool types have not been found at Swifterbant, nor has a canoe, it is possible that canoes were fabricated at a different site. Beaver teeth may also be an indication of wood working. Ethnographic research revealed that beaver teeth are used as chisels for finer wood working (Osgood 1940: 84, Clark 1975: 122-124). They were also recovered at Polderweg and De Bruin (Louwe Kooijmans et al. 2001a, Louwe Kooijmans et al. 2001b). Even at Emmeloord a beaver tooth pendant was found (Kerkhoven 2001).

Other stone artefacts suggesting certain activities are retouched pieces, ornaments, and radial pyrite. The retouched pieces are very limited, like a scraper and a retouched blade. These two tool types are often related to processing hides or food stuffs. Ornaments by themselves do not indicate production at the site, while the presence of unfinished specimens and raw materials do. However, ornament production, but also the discarding and loss of ornaments, suggests extended periods of stay[30] at the site. The small fragment of radial pyrite at site S3, together with the strike-a-lights found at the same site are an indirect indication of making fire. The fragment of radial pyrite does not show any traces of use like a groove or impact points. The weathering of the surface might have erased the traces or this particular piece of radial pyrite may not have been used.

An artefact type not used in this study's typological list is the cooking stone or fire-cracked rocks (see section 3.3). Roughly 40 quartz, quartzite, and quartzitic sandstone cobbles and indeterminate fragments show traces of heat exposure. These are recovered from sites S2 (n: 6), S3 (n: 19), S4 (n: 3), S51 (n: 1), and trenches S21-S24 (n: 10). In Meso-America the practice of recycling tools as cooking stones has been observed, especially when no other stones were available (Adams 1994). As a certain limit or strain on the stone supply has been established, this may be one of the explanations why so many tools are exposed to heat. Still, the combination of cobbles, indeterminate fragments and tools out of quartz, quartzite, and quartzitic sandstone showing traces of heat alteration result in 85 artefacts which is generally low. The use of pottery possibly made cooking stones obsolete.

Temper production may also be suggested by small amounts of white quartz and red granite, or at least red feldspar from red granites, occurring among the artefacts < 3 g. White quartz is present on sites S2, S3, S4, S51, S61, and trenches S21-S24 while red feldspar is only present at sites S2 and S3. Both minerals are used as temper for the typical Swifterbant pottery. Small groups of white quartz or red feldspar may indicate the production of temper at the sites. However, the lack of spatial information prevents the detection of any patterns.

Finally, there is the question of the large amount of grit (artefacts < 3 g) at sites S4 and S61. Currently this issue cannot be resolved. Several activities and phenomena lead to the fragmentation of stone artefacts, such as heat exposure, moisture, and possibly even trampling. Yet none give a sufficient satisfying explanation for such large amounts of grit, and especially why it should occur on these two sites and not the others.

4.8.3 The significance of debitage material

This class of artefacts is present on all but one site. The absence of debitage material at sites S80-S83 is most likely the result of the limited research conducted at the sites. The same applies to site S41 where only one flake was found together with a tool and an axe fragment. Therefore both sites are excluded from this section.

As said, the debitage material is similar in proportions at sites S2 and S4, roughly 30% of the artefacts ≥ 3 g, whereas site S3 has slightly more debitage material (42%). In trenches S21-S24 this is only 8% as the overwhelming amount at the site is waste material. At site S51 the debitage material forms approximately half of the artefacts ≥ 3 g and at site S61 this is 63%. As the overall number of artefacts ≥ 3 g on the two latter sites is rather limited, the significance of these percentages may be questioned. Still, the fact remains that 1370 pieces of debitage material are spread over six sites[31].

The overwhelming dominance of flakes over blades may be observed at all sites (34% versus 1% of the artefacts ≥ 3 g). Most likely this is the result of the raw material itself. The coarseness of the stone types does not allow for the systematic removal of long and fine detachments. One of the only raw material types that is suited for such systematic blade debitage is quartzite, and this is found at the sites only in relatively small quantities.

With flint, the purpose of debitage material such as flakes and blades is the production of tool blanks. For stone tools this appears to be different. Almost all tools at the Swifterbant sites are unmodified pebbles and cobbles. The most obvious exceptions are a scraper, a retouched blade, and a possible microlith fragment produced out of quartzite at site S3. The nature of this raw material is very suitable for the production of flakes and blades as it is similar to flint. Thus the few quartzite flakes may be interpreted as tool blanks and the many quartzite chips may be evidence of debitage at the sites, especially at site S3 where 77 of the 100 quartzite chips occur; but what is the explanation for the remaining 1190 pieces of debitage not produced out of quartzite? None of them is modified into some sort of tool. Of course, flakes can be used as tools without leaving any use traces visible to the naked eye. At the Hazendonk site of Schipluiden evidence was found of wood working on several stone flakes (van Gijn & Houkes 2006). This may also be the case at Swifterbant, especially because numerous pointed wooden posts were retrieved at the sites (Casparie et al. 1977).

The deliberate fragmentation of grinding stones may be interpreted as a second source for flakes. Indeed, a total of 46 flakes from grinding stones have been uncovered at sites S2, S3, S4, and S51. Then again, 57 indeterminate fragments with traces of smoothing or polish have also

30 With the term 'extended periods of stay' an occupation of roughly a week up to a few weeks is intended in this research, i.e. longer than 2-3 days.

31 Or 1371 pieces of debitage spread over seven sites when site S41 is included.

been found on those sites. With the presence of 200 cores, it may be questioned whether there was any need to use grinding stones as an alternative source for flakes. Also, why is the fragmentation rate five times higher for the grinding stones than for hammerstones or anvils? These tool types have some of the same qualities as the grinding stones and yet, they are not used as cores. It has been argued (see Devriendt 2008 a) that this deliberate fragmentation signifies a special treatment of grinding tools. Besides all sorts of functional explanations, deliberate destruction as some form of ritual must be considered.

Besides the noteworthy presence of flakes and a few blades, the absence of rejuvenation pieces is maybe even more remarkable (see section 3.3). As flakes and blades, along with cores and chips, point toward the debitage of stone artefacts, i.e. other than flint, rejuvenation pieces are to be expected. We must however keep in mind that the stone rejuvenation pieces do not necessarily need to resemble the flint rejuvenation pieces. The flint cores at the Swifterbant sites are not always rejuvenated by using striking edge rejuvenation pieces, but sometimes have been reoriented a quarter or half turn in order to maintain the striking platform. If this technique was also applied to the stone cores it is unlikely this would be discernible. The coarseness of the raw material obscures ripples, hence impeding the determination of the debitage axis of flake scars of the dorsal face of flakes. Even on quartzite flakes it is hard to nearly impossible to distinguish the debitage axis without the bulb.

Another observation is the absence of the bipolar technique in the stone assemblage. Again, this technique is regularly observed with the flint material yet not seen with absolute certainty on any of the stone artefact types. Possibly, visibility due to the coarseness of the raw material may be of importance here. Then again, impact points are, due to the crushing of the crystals, often clearly visible. The bipolar technique is in Scandinavia commonly adopted for working poor quality raw materials such as quartz (Callahan 1987, Knight 1991). In the absence of quartz and quartzite cores, this hypothesis can however not be corroborated. One might take the argument even further. The absence of such cores may simply mean the bipolar technique was not needed.

4.8.4 Mobility, territory and raw materials

In the mobility radius a distinction between several action radiuses can be made. Depending on the research prehistoric land use may be divided into three or more zones. For example, Bakels (1978) and Louwe Kooijmans (2001a) use three. The first is the daily activity radius or site territory for daily subsistence and activities such as gathering food and other resources[32]. The second radius is the year territory of the group or family, the locations of the settlements visited within a one year cycle. The third radius is the sphere of influence, the range of expeditions and the network of contacts as seen in the exchange of exotic materials (Bakels 1978, Louwe Kooijmans 2001a).

Binford (1982) and Newell (et al. 1990, Houtsma et al. 1996) use up to five different zones with the camp radius, i.e. the immediate surroundings of the camp, as the smallest. The foraging radius is the area exploited by work parties who return home in a single day, whereas the logistical radius "is the zone which is exploited by task groups who stay away from the residential camp at least one night before returning" (Binford 1982: 7). Beyond that, the extended range and the visiting zone form the outer boundaries of the land use.

Personally I give preference to using the terms site territory, year territory and sphere of influence. Yet, the distinction of the year territory into a logistical zone and an extended zone is more subtle, and seems to be required to properly define prehistoric land use. Therefore, both systems will be used.

The site territory (Higgs & Vita Finzi 1972) or foraging zone (Binford 1982) is the area around the site that is normally exploited by the inhabitants. For farmers this is defined as one hour's walking distance, for Mesolithic foragers this is a two hour walking distance (Vita Finzi & Higgs 1970, Higgs 1975). On an even terrain and with a light burden, a distance of 5 km per hour may be travelled on foot. When river systems and a canoe are used a distance of 10 km seems plausible (Louwe Kooijmans 2001a, Andersen 1994). Binford (1982) also sets the limit of the foraging zone at six miles or roughly 10 km. Areas farther away, i.e. the logistical zone, will be exploited by two- or three-day trips, or even longer expeditions.

The number of glacial erratics makes me conclude that the boulder clay outcrops are the primary source for stone artefacts at the Swifterbant sites (see section 4.3.3). The outcrops of Urk and Schokland (10 and 14 km) were postulated as the most likely procurement areas. The deposits of Urk are indeed located at the limit of a one-day trip's reach, whereas the outcrops at Schokland presumably required a two-day trip.

The second radius, or logistical zone, is the 6 hour walking distance or a 30 km action radius, a distance to be covered in a full day's walk (Bakels 1978, Houtsma et al. 1996). Again, one of the two possible sources of southern stone material, a supplementary yet well considered source, is located at the limit of this radius (the Veluwe 30-70 km). The second area, the Utrechtse Heuvelrug

32 The term home range will not be used as Bakels (1978) explained that two different definitions exist. This would only lead to confusion.

between 40-70 km would imply a three- to four-day travel back and forth. These distances imply that the latter two procurement sites were located within the year territory or the extended range.

All other raw materials, i.e. the non-local and/or exotic materials, occur rarely at the Swifterbant sites and may be procured between 70 or 100-150 km up to 250 or 330 km from the sites. This clearly is the largest activity radius also known as the sphere of influence or visiting zone.

4.8.5 Technology, method and technique

The variation within the technology of the stone assemblage is rather limited. The methods used to create stone tools are simple and restricted[33]. Most of the tools were made from pebbles and cobbles without much shaping. Therefore ready-to-use round specimens of glacial erratics from the boulder clay outcrops were carefully chosen. Certain raw material types and weight classes were selected, possibly with a specific function already in mind. Cobbles with two opposing flat surfaces or a pyramid shape were clearly preferred. Raw material types were chosen for their inherent qualities, tough types for axes, compact and cemented types for hammerstones, and somewhat more abrasive types for anvils and grinding stones.

Debitage has been observed quite regularly. The reason for this debitage was diverse and applied in different intensities. Sometimes it is even hard to set the different goals apart. Whether a cobble was knapped for the production of tool blanks, for the production of temper, for the destruction of grinding tools, or for some other type of activity still unknown, is mostly hard to determine. The production of tool blanks could be confirmed in a few isolated cases. Temper may be produced by pounding cobble fragments and flakes into grit, with or without the help of fire and many grinding stone fragments and polished flakes have been counted. These flakes may however have been used as tools without any form of modification, as seen on other sites (Schipluiden).

The applied debitage technique was simple and straight forward. Flake debitage was the only presumed goal, as most raw material types do not allow systematic blade production by the nature of their raw material, i.e. its coarseness. The production plane, or at least a good striking angle, was possibly maintained by turning the core, thus not by refreshing the striking edge as with flint. It is possible that the same technique as observed with the flint was applied, thus reorienting the core by a quarter or half turn. The absence of rejuvenation pieces may also be a true fact. Maybe the coarseness of the raw materials simply did not allow such 'difficult' techniques. Detaching flakes from a platform was perhaps the most complex thing possible.

The manner or mode of debitage seems to be restricted to hard hammer percussion. Impact traces are nearly always visible on the butt of the detachments. The artefacts without an impact point are not defined as flakes or blades. Maybe these are detached by a soft hammer, resulting in the absence of certain features typical for hard hammer percussion. In the absence of systematic research on hard and soft hammer percussion on different stone types other than flint, this is only a suggestion.

4.8.6 Conclusions

The analysis of the stone assemblages suggests that the sites in the Swifterbant area were characterised by extended periods of habitation. People stayed long enough to produce all kinds of tools, debitage material, and waste but also had time enough to produce, discard, and lose ornaments.

That these groups of people consisted of complete households is confirmed not only by the very wide variety of archaeological finds, such as pottery and tools produced out of different kinds of organic material, but also by the cemeteries where men and women, young and old were buried side by side. A broad variety of activities is also confirmed by the typological composition of the lithic artefacts. As we may presume that certain activities are gender based, the flint and stone tools also suggest the presence of (extended) families.

The sites, located within a few hundred metres from each other, were integrally part of the site territory. Most resources must have been readily available within this or the nearby territory. Yet, stone and flint is not present in the soils around Swifterbant. The analysis revealed that the boulder clay outcrops are the primary source for stone supply to the sites. The outcrops of Urk and Schokland (10 and 14 km), but possibly also the other outcrops in the Noordoostpolder, are located at the limit of a one-day trip's reach. The location of the Swifterbant sites in the palaeo-IJssel river system and the boulder clay outcrops in the Vecht system, must have given some strain on the supply, even with a canoe. The river systems are, as it happens, not connected, which meant a certain distance of travelling over land when going to the east, or a long way round over water to the west.

More to the south, a second yet clearly supplementary source of stone supply was exploited. The Veluwe and the Utrechtse Heuvelrug (30 and 40 km) are accessible in a three- to four-day travel back and forth. Specific types of raw material were selected there and brought back to the sites. Finally, non-local raw materials such as amber and radial pyrite but also imported shaft-hole axes suggest a

33 For the definition of concept, method, technique, and manner or mode see section 5.5.1.

sphere of influence reaching as far as 100 km to the north, and possibly even more than 250 km to the south.

Even though the sites are part of one big territory, and were inhabited within roughly the same time span, variations in the toolkits and debitage assemblages suggest similar, yet not identical activities with different intensities and combinations. The presence of a cemetery on a certain number of them already suggests by itself a different function of the sites.

The three levee sites S2, S3 and S4 are the most similar in stone artefact composition and artefact type representation. High percentages of waste are observed at all three sites (between 45% and 60%), while debitage material takes second place. Thus twice as much waste material is present on sites S2 and S4 (1.5:1 and 2:1) while this is roughly the same at site S3 (45 % versus 42%), mostly because of the larger amount of debitage material than at sites S2 and S4.

These small differences in numerical presence of artefact categories, raw material preference, tool composition or debitage material give them an individual character. The raw material dominance of granite on both sites S2 and S4 sets them apart from site S3 where quartzitic sandstone is preferred. The significant amount of granite on site S2 is the result of its use as debitage material and waste, whereas tools are preferably produced out of quartzitic sandstone and gneiss. On site S3, the dominance of quartzitic sandstone is caused by its use for large amounts of the debitage material and the tools. A comparable selection of certain stone types for certain tool types indicates that the people at Swifterbant were well aware of the characteristics of each stone type. Hammerstones and anvils are preferably made out of quartzitic sandstone as it best absorbs impact blows, although the selection for anvils is somewhat less strict than for the hammerstones. The grinding tools show an even wider variety of raw material types and are as often produced out of granites and gneisses as the anvils. The dominance of different types of sandstones and quartzites for the grinding tools is somewhat unexpected as granites and gneisses are more abrasive. As granites and gneisses occur regularly at the sites, this must be a conscious choice and not the result of scarcity of abrasive stone types. It was observed that the grinding orientation may be in accordance with the bedding of the raw material to loosen as few minerals as possible. This is most likely why compact stone types were preferred over abrasive types.

All these different tool types, present at the three sites, indicate all sorts of everyday activities. Hammerstones can be used for lithic debitage, the roughening of grinding stones, or pounding temper and may also be used for processing food like cracking nuts or squashing seeds and herbs. Anvils also indicate flint working, the pounding of temper and food production together with crushing of any other material. Grinding stones provide evidence of processing different kinds of grasses or early cultivars. Little grinding stones, produced on pebbles, may be considered as polishers, perhaps to smoothen pottery or work hides. The dominance of grinding stones over anvils and hammerstones is observed at sites S2, S3 and S4. This is even more so when the ground stone fragments are included. At site S2 their presence in terms of percentage is considerable. Both sites S3 and S4 have high numbers of combination tools, and of hammerstone / anvil combinations in particular. Yet again, the high fragmentation rate of the grinding stones and ground stone fragments makes it hard to determine their original number, and thus their original part in the tool kit. When the tools are divided by function[34] it appears that site S2 is dominated by tools with a grinding function, site S3 by anvil and hammer functions, and site S4 by tools with anvil functions.

With the occurrence of axes it is likely that the grinding stones were also used for polishing or re-sharpening the cutting edges of the axes; up to four local copies of shaft-hole axes were found. It seems that the Swifterbant people did not suffice or were not satisfied with the limited supply of shaft-hole axes and started to make their own. Of these four local copies of perforated axes two are rather special. The cutting edge of these two axes is somewhat tilted in comparison to the perforation. The suggestion that this would make the tools unusable is rejected as use-wear analysis clearly proved the usability of these tools. Based on the analogy with other archaeological sites and ethnographical research, the axes on their part may signify wood working. The same accounts for large flakes and beaver teeth. Two axes with oval cross section on site S3 have pecking or impact traces on their butts, suggesting they might have been used as wedges.

Site S51, the levee site in the isolated position located more to the northwest, corresponds well to the picture set by sites S2, S3, and S4. The same three basic tool functions and the same debitage composition are present suggesting similar use of the site. The dominance of debitage material over waste material is the only difference with the three other levee sites, yet is in common with site S61. The erosion and partial excavation of the site may be of significance here.

Other levee sites such as sites S31 and S41-S43 may be very similar to sites S2, S3 and S4 as well. The discovery of a flake, a hammerstone / anvil combination and an axe fragment on site S41 give proof of this theory.

To conclude, the composition of the stone assemblage in terms of diversity is limited and very similar at all levee sites, only the mutual proportions seem to differ slightly. Indeed, as site S51 may be different from sites S2, S3 or S4, it cannot be ruled out that any of the sites S31 and S41-S43 is different as well.

34 In this calculation the ground stone fragments are excluded as these are hard to quantify in real numbers.

The river dune sites on their part are very different. For example trenches S21-S24, around 4500 BC this site was chosen to be used as a cemetery. Even though the number of artefacts ≥ 3 g in trenches S21-S24 is comparable to those of sites S2 and S4, the low number of artefacts < 3 g, debitage material, tools and especially the low percentage of chips, combined with the high numbers of waste material consisting of indeterminate fragments and pebbles, suggests the limited residential use of the site. And even though there is currently no way of knowing which stone tools belonged to which habitation phase, based on the stone analysis alone, the position of the river dune site in the landscape, i.e. at the creek nearest to the Vecht system and the boulder clay deposits, may suggest it was used as a storage place for raw materials.

Finally, site S61 that with its low number of artefacts ≥ 3 g is hardly comparable to the other sites. Still, the very high percentage of artefacts < 3 g makes the site as peculiar as site S4. Debitage at the site is established by the presence of flakes and chips, whereas certain activities such as flint working and food processing are confirmed by the presence of anvils and grinding tools. It is believed that the larger part, if not all, of the stone assemblage is of Neolithic origin.

Almost all tools at the Swifterbant sites are produced on unmodified pebbles and cobbles, yet a high number of debitage materials were observed. The goal of this debitage was diverse and applied in different intensities.

The production of tool blanks could be confirmed in a few isolated cases, while temper may be produced by pounding cobble fragments and flakes into grit, with or without the help of fire. However, these flakes may easily have been used as tools without any form of modification as seen on other sites like Schipluiden.

Additionally, many grinding stone fragments and polished flakes have been counted. It has been argued (see section 4.8.3) that this deliberate fragmentation signifies a special treatment of the grinding tools. Besides all sorts of functional explanations[35], deliberate destruction as some form of ritual, maybe at settlement abandonment or possibly during burial practices, must be considered.

The debitage technique was aimed at the production of flakes. The operational chain was simple and straight forward with the maintenance of the production plane, or at least a good striking angle, by turning the core. Noteworthy is that no bipolar technique has been observed. The manner or mode of debitage seems to be restricted to hard hammer percussion.

Thus, the evidence above indicates the intense use of site S3. The site has a highly residential character and gives proof of all sorts of household activities by its high number of debitage material and tools. In this respect, site S4 is very similar to site S3; it may possibly even be seen as an annexe to site S3. Yet, site S4 shows small differences. The presence of the child's grave and the numerous artefacts < 3 g are examples of this somewhat different character.

The isolated position of site S2 is not the only characteristic distinguishing the site from sites S3 and S4. The cemetery and the dominant amount of tools with a grinding function give the site the allure of a special activity site. This interpretation, however, needs to be regarded with due reservation as only a relative contemporaneity between the graves with the stone assemblage is corroborated. The interpretation of the deliberate destruction of grinding stones as a part of some sort of grave ritual is therefore only tentatively put forward, especially as this phenomenon is not observed at the cemetery in trenches S21-S23.

35 Some examples of functional explanations are the production of flakes, thus the re-use of discarded grinding stones as cores, accidental fracturing during roughening, or as raw material for temper production. Still, this interpretation of a second method to produce flakes, complementary used with traditional debitage, is in contrast with the suspected special activity site interpretation of site S2.

Chapter 5

The analysis of the flint artefacts

5.1 Introduction

Over the last few decades, flint analysis evolved from a strictly typological descriptive system to a wider and more dynamic approach. Typology was complemented with raw material analysis, refit analysis, use-wear analysis, and technological attribute analysis. All these aspects provide a wider range of information on site function, subsistence strategies, mobility, and social structure than typological analysis alone can provide. And although these investigation techniques are generally known to all flint researchers, technological attribute analysis is seldom performed in detail due to its time-consuming, and thus expensive aspects. This study makes use of this technique, providing proof of its highly revealing character and its ability to offer supplementary information.

5.2 Artefact types and amounts

5.2.1 Total of all sites

The large number of stone and flint material, approximately 88,500 pieces, was studied with different focus points to gain an insight into various aspects of the material. Most artefacts have been studied in full detail for typological reasons, some have been analysed to gain more technological insight, and others for reasons of quantity. The downside of this varied research is that data cannot always be fully compared with each other. One site was not studied at all and that is trenches S11-S13 as this material is currently still in the United States of America. R. Whallon Jr. showed a renewed interest in the material when this research was started. After 30 years a publication is being prepared by him and his team. The analysis of trenches S11-S13 or of trenches S21-S24 only makes sense when it can be compared to the other, therefore the material of S21-S24 is only analysed superficially. Furthermore, the current state of affairs does not allow the clear and integral separation of the Mesolithic flint assemblage from the Neolithic admixture. All these reasons indicate that a thorough analysis of the flint material from river dune sites might be more fruitful in the near future than when the analysis would have been done now.

A total amount of c. 44,000 flint artefacts have been studied in detail[1], weighing a total of c. 70 kg. This large number is divided into two groups according to their length along the debitage axis[2]; one group measuring less than 1 cm (artefacts < 1 cm) and one group measuring equal to or more than 1 cm (artefacts ≥ 1 cm). The first group comprises c. 14,900 pieces of flint, weighing c. 1,7 kg. The second group is larger and is made up of c. 25,100 pieces with a total weight of c. 68.4 kg. The artefacts ≥ 1 cm include 16,620 pieces of debitage material, 2766 tools, 837 bipolar pieces, 700 artefacts with visible use-wear traces, 4163 pieces of waste and 45 other artefacts of which 41 polished flint axe fragments. An additional 12,103 pieces were only counted and weighted, not determined by artefact type.

5.2.2 Site S2

General aspects

The flint assemblage of site S2 presumably is a combination of material from several old excavation campaigns (1964 - 1979) and one recent excavation campaign (2004) (see catalogue section 2.2.2). In total c. 460 m² was excavated which is roughly 58% of the site3.

The flint artefacts comprise 359 artefacts < 1 cm and 1027 artefacts ≥ 1 cm (table 5.1)4. The latter make up 74% of the flint material and are defined as 505 pieces of debitage material (49%), 198 tools (19%), 26 bipolar pieces (3%), 65 artefacts with visible use-wear traces (6%), and 233 pieces of waste (23%).

Almost half of the artefacts ≥ 1 cm (49%) are made of fine-grained flint without bryozoans. Fine-grained flint with bryozoans is employed for 15% of the artefacts; thus the fine-grained flint forms 64% in total. Rarely used flint varieties are medium- and coarse-grained flint (together

1 During the long research and excavation history at the different sites an additional amount of artefacts was uncovered in the Swifterbant area. Unfortunately, it is no longer known to which site they originally belonged. Therefore, they are discussed in appendix 3.

2 For methodology see chapter 3; for typology see appendix 1; for a detailed description of the material see catalogue chapter 2.

3 The extent of the excavated area excludes the trenches in the back swamp areas.

4 The sample of 188 artefacts analysed by Raemaekers (1999: 35-37) appears to have been lost.

Table 5.1 Total number of artefacts per typological category of site S2.

	Number	%	% ≥ 1 cm
Debitage material	**505**	**36.4%**	**49.2%**
Flakes	107	7.7%	*35.5%*
Flake fragments	194	14.0%	*64.5%*
Total flakes	***301***		***100%***
Blades	17	1.2%	*9.4%*
Blade fragments	164	11.8%	*90.6%*
Total blades	***181***		***100%***
Rejuvenation pieces	10	0.7%	
Cores	13	0.9%	
Tools	**198**	**14.3%**	**19.3%**
Scrapers	28	2.0%	
Borers	12	0.9%	
Rounded pieces	9	0.6%	
Trapezes	7	0.5%	
Transverse arrowheads	1	0.1%	
Tools on flake	23	1.7%	
Tools on blade	59	4.3%	
Tools on other blanks	7	0.5%	
Indeterminate tools	4	0.3%	
Indeterminate tool fragments	38	2.7%	
Retouched chips	10	0.7%	
Bipolar pieces	**26**	**1.9%**	**2.5%**
Visible use-wear	**65**	**4.7%**	**6.3%**
Waste	**233**	**16.8%**	**22.7%**
Indeterminate fragments	78	5.6%	
Frost flakes	28	2.0%	
Potlids	110	7.9%	
Nodules	17	1.2%	
Subtotal ≥ 1 cm	***1027***	***74.1%***	***100%***
< 1 cm	**359**	**25.9%**	
Total	**1386**	**100%**	

3%). For the tools, the use of fine-grained flint without bryozoans reaches as high as 56%; for the bipolar pieces this is even as high as 85% (see catalogue tables 2.2 and 2.3). When fine-grained flint with and without bryozoans are combined, the artefacts with visible use-wear traces score high as well. The lowest number of fine-grained flint with bryozoans is discernible for the waste material. Of the 29 artefacts made out of medium- or coarse-grained flint, 7 are tools (24%); for the fine-grained flint types this is 23%.

Up to 498 artefacts, which is 48 % of the larger artefacts, are exposed to heat, hampering the raw material determination of 339 pieces (33%). Moderate heat exposure occurs most often. When flake and blade fragments are taken out of the equation the debitage material is burnt less often than the tools. Yet, the high burning rate of the fragments gives the opposite picture. The fragmentation of the flakes and blades may largely be a natural result as burning leads to fragmentation; the same applies to the high percentage of burnt specimens within the group of retouched chips. The high percentage of burnt waste materials is mainly the result of the potlids within this category. When these are excluded the numbers drop to 57%, which might still be considered rather high, as a result of the exposure of the numerous indeterminate fragments.

Debitage material
The largest category of finds is the debitage material consisting of 301 flakes, 181 blades, 10 rejuvenation pieces, and 13 cores[5].

The majority of the flakes were detached in a unidirectional manner, while 16 of them (5%) are defined as bipolar flakes. In total, 64% of the flakes are broken. Of the remaining 107 intact flakes, 72% are partially covered with natural surface, being some kind of cortex or patina, whereas 20% are defined as decortication flakes (coverage of 75% or more). The intact flakes have average measurements of 17x15x4 mm and an average weight of 1.47 g.

As with the flakes, most of the blades were detached in a unidirectional way (96%). The remaining 7 blades are characterised by bipolar debitage. The unidirectional blades most often have parallel edges and ridges (64%) implying systematic blade production or at least a preference for such 'regular blades' (see section 3.1.2); only a small number is produced less systematically and can rather be defined as 'irregular blades'. The fragmentation rate of the blades is, however, much higher than for the flakes; up to 91% of the blades are broken, which is in general a very high number. These fragments are defined as 46% medial parts, 31% proximal-medial parts, and 23% medial-distal parts. The 17 intact blades have average measurements of 28x11x4 mm and an average weight of 1.74 g. Roughly half of these are partially covered with natural surface, i.e. cortex or patina, however none are covered for up to 75% or more. It is also observed that the percentage of flake and blade fragments with natural surface is less than their undamaged counterparts, 43% and 29% respectively.

The rejuvenation pieces are defined as seven striking edge rejuvenation pieces, two platform rejuvenation pieces, and one core tablet. The average measurements

5 For definition problems on flakes versus blades see section 3.1.2

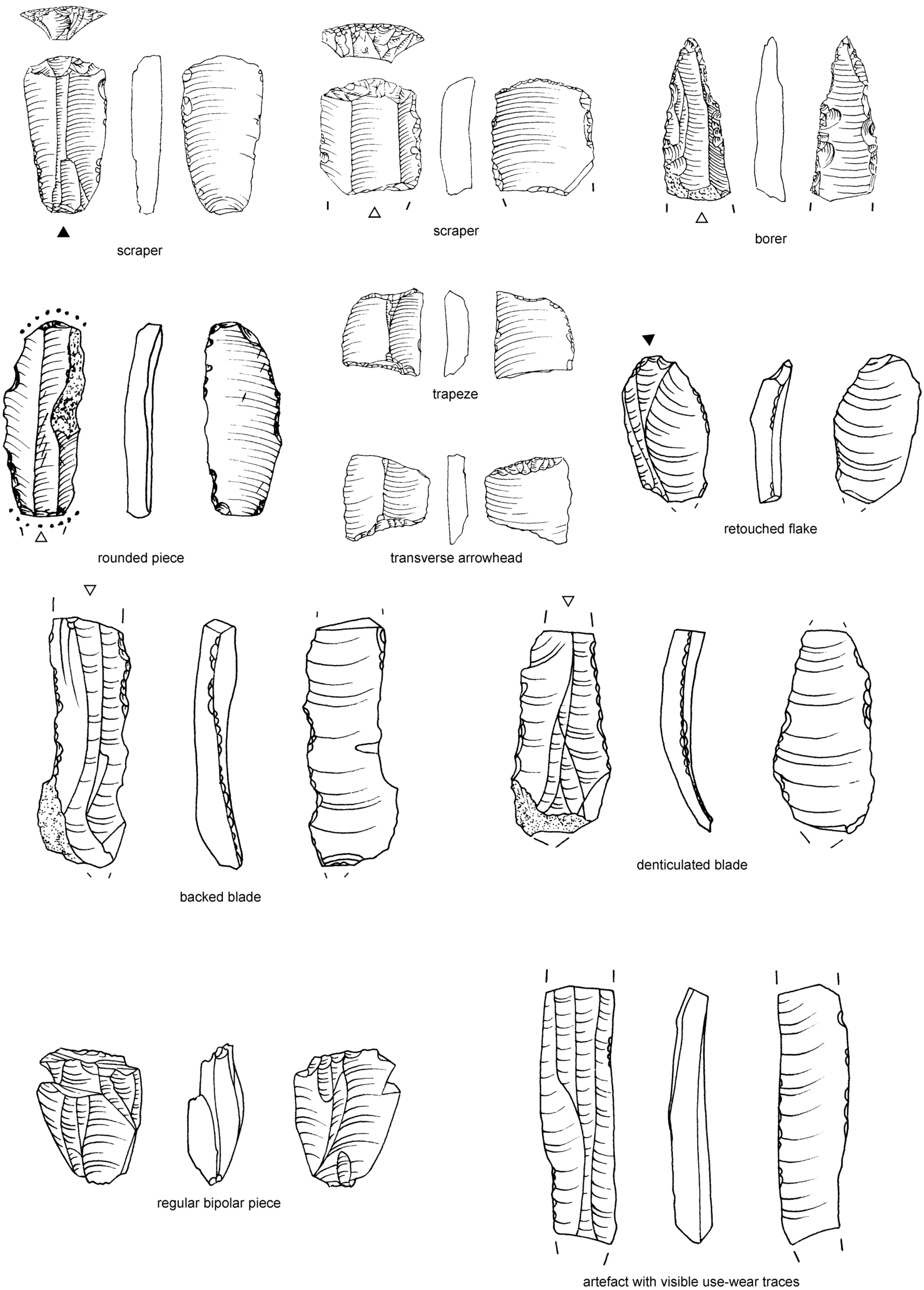

Figure 5.1 Overview of tool types present at site S2. Scale 1:1

of the rejuvenation pieces are 23x17x5 mm. The highest measurements are for a fragmented striking edge rejuvenation blade of 44x29x7 mm. Noteworthy is the presence of blade-rejuvenation combinations, which indicate the necessity of a second blow to detach the artefact as the first blow did not detach a sufficient length of striking edge.

The cores, almost exclusively tested cores, are rather irregular shaped and only have two to a handful of flake scars, mostly chipped off rather randomly. Their natural surface is therefore still covering large parts of the artefacts, from approximately 25% to almost 100%. Suitable natural surfaces are most often employed to start debitage, as core preparation is very limited. Noteworthy is that the cores form 3% of the debitage material, which seems rather limited to produce all the flakes and blades. The average measurements of the cores, 28x25x14 mm, are also insufficient to produce some of the larger blanks. The presence of cortex and patina proves that these small cores are not the end result of extensive debitage production. Even more, no coarse-grained rejuvenation pieces or cores have been found at the site, yet three coarse-grained artefacts were discovered, all pointing to an 'off-site'[6] debitage production, i.e. production elsewhere. The extraction of rejuvenation pieces and cores from the site may not be excluded, as the dominance of fine-grained flint with and without bryozoans is reflected in the cores.

Tools

The flint tools are a collection of 28 scrapers, 12 borers, 9 rounded pieces, 7 trapezes, 1 transverse arrowhead, 89 retouched pieces, 42 indeterminate tools or fragments thereof, and 10 retouched chips (figure 5.1). The selection of raw material focuses on fine-grained flint. This selection was not as strict for the retouched blades. The percentage of heat exposed specimens is lower than for the debitage material.

The predominance of end scrapers is overwhelming (94%). Mostly they are single, with or without retouch on the edges, and only seldom a double end scraper occurs. They are generally produced from (regular) blades. The scraper front is dominantly positioned distally and is rectilinear, curved or rounded. It appears that when the scraper front broke off, which regularly happened considering the numerous scraper fragments (46%), a new front was fabricated, resulting in smaller specimens. Noteworthy is the abundance of these short blade scrapers. Most likely re-sharpening, without prior breakage, occurred as well, resulting in even more small specimens. Some larger end scrapers have gloss on one or two of the edges of the blade. This suggests a prior, a secondary, or an alternate use. Other types of scrapers rarely occur; only one rounded scraper was observed. It differs not only in shape, it is also the only scraper with indirect retouches. This dominance of end scrapers is also discernible with the scraper fragments, as their general appearance suggests. The dimensions of the scrapers are loosely grouped with average measurements of 19x14x4 mm; one specimen is larger measuring 42x19x6 mm.

The variation within the small set of borers is rather large. The borer's tip may have straight, curved, or oblique retouched edges and the tip is as often located proximally as it is distally, even direct and indirect retouches are used in turn. The only common practice is the use of blades as blanks. Unfortunately, nearly all specimens are damaged, yet the averages of 32x14x4 mm are given for comparative reasons. Rounding at the tip is observed on a few occasions suggesting intense usage, whereas gloss on the edges of the blades indicates a prior, secondary, or alternate use of the blank or tool.

The rounded pieces are made up of blades with or without retouches on the edges and rather small artefact fragments. Some of the blades even have two rounded ends. It has been argued in section 5.4.3 that the activities resulting in the rounding-off of tips can be diverse. Furthermore, several other tools show rounding at their tips like scrapers, borers, retouched blades, and indeterminate tools.

Within the group of arrowheads, there is a preference for asymmetrical trapezes made from blades. They are all very much alike with direct, abrupt, short retouched edges. Only one transverse arrowhead was found, which morphologically does not differ greatly from the trapezes, yet it is characterised by alternate retouches. The average dimensions of the arrowheads are 15x11x3 mm with a length-width ratio varying between 1.1 and 1.9, and 1.0 for the transverse arrowhead, resulting in an average of 1.3.

The collection of retouched pieces mainly consists of retouched blades and to a lesser extent of retouched flakes and other types of retouched blanks. The retouched edges of retouched flakes generally follow the natural convex, rectilinear or concave curvatures of the blank or use an existing fracture; denticulated or notched edges occur only once or twice. Typical retouches are short, abrupt or semi-abrupt. Most of the tools are fragmented. The undamaged fraction measures between 13x14x1 mm and 45x24x5 mm which results in an average of 30x20x5 mm.

The retouched blades, the largest group of tools, are predominantly backed blades that are retouched along the edges without altering the general shape of the straight edges, whereas retouches that lightly alter the line of the edge are far less frequent. Moreover, only a few denticulated, notched or truncated blades occur. The retouches

6 The term 'off-site' is used as opposed to 'on the site'.

can be located on one or two edges, dominantly dorsally but also ventrally; on the denticulated blades this is often a combination of direct and indirect short retouches. Predominantly regular blades with two parallel ridges were used. The high fragmentation rate of 90% is noticeable as is the dominance of medial parts over proximal-medial and medial-distal parts. Besides clearly retouched edges, several blades also present use-wear traces such as gloss and use-retouch. Due to the high fragmentation rate it is challenging to say anything significant about the full length of these artefacts. Still, the blades can be compared to other blades like those with use-wear traces. Thus, the complete blades have average measurements of 35x12x4 mm while the fragments have an average of 27x14x4 mm with a maximum of 53x22x6 mm, which is longer than any of the undamaged blades. The average measurements of both the intact and the fragmented retouched blades are smaller than these of the blades with visible use-wear traces, yet larger than the unretouched blades.

All of the remaining retouched pieces have simple retouched edges. The blanks used for all but one of these tools have dimensions comparable to unretouched blanks. Only one retouched striking edge rejuvenation piece is considerably longer than its unretouched counterparts (57x21x8 mm). Maybe the size was the reason for the selection of the blank.

The rest of the toolkit consists largely of different sizes of indeterminate tool fragments, like possible fragments of trapezes, truncated blades, borers, or scrapers. Even the indeterminate tools are no longer assignable to a specific tool type; partly because of their sustained damage, and partially because of some type of re-usage.

As a concluding remark, it was observed that when the size of the tools is set against that of the flakes and blades, all of them fall within the measurement limits of the blanks present at the site. The only exception is the large retouched rejuvenation piece. When the sizes of the tools are compared with that of the cores and nodules, the flakes may have been produced at the site but most of the blades were not.

Remaining flint material

The bipolar pieces, nearly exclusively made out of fine-grained flint without bryozoans, can be divided into 6 regular and 20 irregular specimens. The regular pieces all have rather similar appearances and sizes between 18x14x4 and 25x21x13 mm (average 21x17x8 mm) whereas the irregular pieces show larger variation ranging from 13x9x4 mm up to 38x33x16 mm (average 24x18x8 mm) with very different appearances. Most of the bipolar pieces still have remnants of natural surface or have frost flake scars indicating that their current size varies little from their original, small nodule sizes. It was observed that a limited number of them do not have just one debitage axis but are reoriented a quarter turn to apply a second debitage axis resulting in two crossed axes.

The artefacts with visible use-wear traces seem to rely on the same preferences as the tools. Regular blades are preferred, mostly from fine-grained flint with or without bryozoans. Noteworthy is their high fragmentation rate (88%) with mostly proximal-medial parts (53%), and to a lesser extent medial (37%) and medial-distal parts (9%). The average measurements for the intact blades are 46x18x5 mm and 33x15x4 mm for the fragmented ones indicating that most fragments are rather large.

The waste material is a combination of potlids, indeterminate fragments, frost flakes, and nodules. A few fragments are remnants of shattered cores or nodules. Together with internal fissures, frost fissures and indistinct impact points, this points towards damaging of the nodules during transport in riverbeds. The average measurements of the nodules are 36x23x14 mm which corresponds with the cores on the site (figure 5.2), yet is rather small compared to some of the flakes and blades.

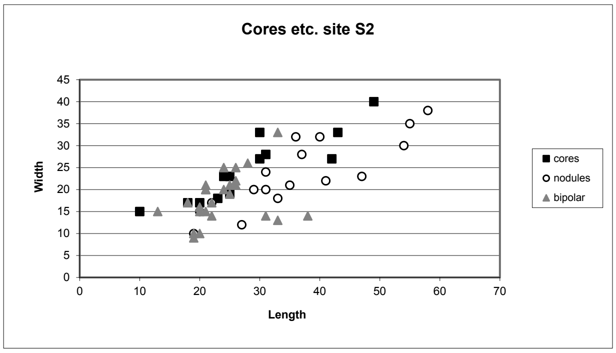

Figure 5.2 Total number of cores, nodules, and bipolar pieces of site S2.

The chips make up 26% of the total flint material recovered from site S2. Their weight ranges between 0.01 g and 0.87 g, with an average of 0.14 g. The weight analysis reveals 87 possible microchips (26%) and the dominance of the 0.05 g weight class. Once past that weight class the number per class decreases. In total 38% of the chips are not damaged by fire, 39% are moderately exposed, 21% are heavily exposed and 2% are lightly exposed; thus moderate exposure is most common. The only special information noted was the retrieval of one chip located between the pelvis in grave V and the forearm in grave VI.

Comparison with Deckers' study from 1979

The article by Deckers (1979) discusses 1503 artefacts deriving from Van der Heide's excavations from 1964 and 1967, along with the material from Van der Waals' excavations from 1975, 1977, and 1978. The 1979 excavation had not yet been undertaken. It appears that roughly 140 flint artefacts from those excavations are missing today. Some of these were identified as tools; others must have been flakes and blades.

His study reveals that the flakes and blades have lengths up to 48 mm and 63 mm respectively, while the longest intact specimens in this study measure up to 40 and 48 mm respectively. This clearly proves that material must be missing. He also pointed out the discrepancy between the size of the cores and the size of the flakes and blades. The flake negatives on the cores are too small to produce the flakes found on the site. This is related to the fact that Deckers did not identify the 'cores with two opposing striking platforms' as bipolar pieces. He did observe however, that the striking platforms had a width of 1 mm or less and that secondary flaking on the proximal and distal ends occurred. He also detected these traces on several flakes. Yet, he does not identify any of them as *pièces esquillées* (ibid: 151). Neither does he talk about bipolar technique or bipolar pieces.

His spatial analysis is valuable, especially since all spatial information is now lost to us. Deckers concludes that all flints seem to be evenly distributed throughout the occupation layer. This accounts for most of the debitage material and tools. Yet, a certain concentration is visible when weight is the discriminative factor. Finally, Deckers assumes that most of the material was deposited after the burials.

Conclusion

For the production of the flint assemblage at site S2, fine-grained flint without bryozoans was preferred above fine-grained flint with bryozoans. This is especially so for the bipolar pieces and the tools indicating the selection of blanks without bryozoans.

The limited number of cores and rejuvenation pieces indicates missing steps in the operational chain or suggests that some of the flakes and blades were not produced at the site. The absence of cores and rejuvenation pieces made out of coarse-grained flint hints at this as well. The other way round, the possibility of the extraction of rejuvenation pieces and cores from the site may not be overlooked. It is unlikely that a low number of cores were reworked into other types of artefacts since no immediate proof of this practice was found. Even the bipolar pieces are not the end product of reduced or re-worked cores; they have too much cortex and patina.

Another point suggesting the production of flakes and blades off-site is the limited size of the nodules and cores at site S2. The size of the nodules is in concordance with that of the cores, i.e. all cores could have been produced out of the nodules at the site. Their types of raw material match as well since no medium- or coarse-grained types occur. Both these artefact categories are, however, rather small in dimensions to produce some of the larger flakes and blades (figure 5.3 and 5.4). The limited size of the cores does not mean they are depleted blade cores as all of them show remnants of natural surface.

Thus, the larger part of the flakes was presumably produced at the site, whereas most of the regular blades were not. The cores and rejuvenation pieces are after all insufficient in length. The bipolar pieces were most likely made at the site, as nodules are sufficient in size and correspond in raw material. Yet, nodules of fine-grained flint without bryozoans were clearly selected for the bipolar pieces. The size of the nodules also corresponds well to the cores. These cores mainly show flake scars completing the circle of flake production at the site. Even more, the absence of decortication blades implies the opening of the cores with flake debitage.

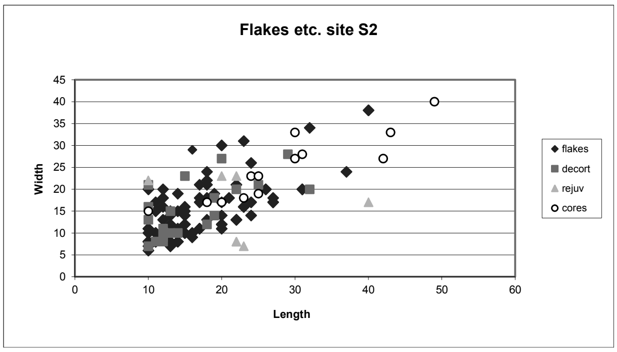

Figure 5.3 Total number of intact flakes, intact decortication pieces, intact rejuvenation pieces, and intact cores of site S2.

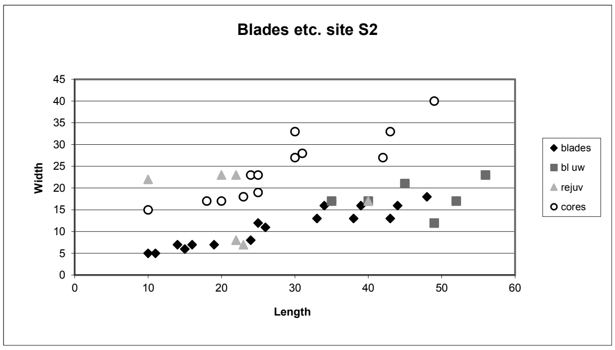

Figure 5.4 Total number of intact blades, intact blades with use-wear traces, intact rejuvenation pieces, and intact cores of site S2.

Compared to the amount of debitage material, the number of tools is rather high, especially the retouched blades. There are also a large number of blades with visible use-wear traces. Moreover, in general tools are mainly produced on blades (at least 58%), although flakes occur nearly twice as much in the debitage material.

Noteworthy is that all borers are damaged or broken, a characteristic shared by several other tool types, especially retouched blades, and by blades with visible use-wear traces. The type of the blank, i.e. blades, is possibly responsible due to its weaker structural integrity compared to flakes; they are longer and thinner. The same might apply to the rounded pieces, often produced on

Table 5.2 Total number of artefacts per typological category of site S3.

	Number	%	% ≥ 1 cm
Debitage material	**11147**	**43.9%**	**68.9%**
Flakes	3824	15.1%	*46.7%*
Flake fragments	4362	17.2%	*53.3%*
Total flakes	***8186***		***100%***
Blades	1061	4.2%	*41.1%*
Blade fragments	1522	6.0%	*58.9%*
Total blades	***2583***		***100%***
Rejuvenation pieces	211	0.8%	
Cores	167	0.7%	
Tools	**1420**	**5.6%**	**8.8%**
Scrapers	435	1.7%	
Borers	27	0.1%	
Rounded pieces	41	0.2%	
Trapezes	40	0.2%	
Transverse arrowheads	6	0.0%	
Tools on flake	205	0.8%	
Tools on blade	209	0.8%	
Tools on other blanks	53	0.2%	
Indeterminate tools	14	0.1%	
Indeterminate tool fragm.	247	1.0%	
Retouched chips	143	0.6%	
Bipolar pieces	**721**	**2.8%**	**4.5%**
Visible use-wear	**468**	**1.8%**	**2.9%**
Polished axe fragments	**38**		**0.2%**
Other tools	**2**	**0.0%**	**0.0%**
Waste	**2375**	**9.4%**	**14.7%**
Indeterminate fragments	713	2.8%	
Frost flakes	392	1.5%	
Potlids	1162	4.6%	
Nodules	108	0.4%	
Subtotal ≥ 1 cm	***16171***	***63.8%***	***100%***
< 1 cm	**9194**	**36.2%**	
Total	**25365**	**100%**	

blades as well, although the application of high force or pressure during usage may also lead to fragmentation. The high fragmentation rate of blades is also visible within the debitage material.

Other features observed with blades are their selection in size and frequent use. It appears that the largest blades were chosen to be used unaltered, i.e. blades with visible use-wear traces (figure 5.4), whereas slightly smaller blades were retouched. Yet, both are larger than the unselected or remaining blanks. Frequent use is established by the gloss on one or two of the unretouched edges when blades were used as retouched tools. This is seen with different tool categories and indicates a prior, a secondary, or an alternate use of those blades or tools. The possibility exists, that when unaltered blades were broken during use, and maybe became insufficient to do the activity at hand, they were transformed into other tools for other purposes.

Finally, the flint material shows a high number of burnt artefacts, which is 48% of the artefacts ≥ 1 cm and is as high as 62% for the artefacts < 1 cm, especially considering the absence of clay structured hearths at site S2. The debitage material was slightly more often exposed to heat than the tools, which has resulted in the many burnt flake and blade fragments. A rather large proportion of the artefacts with visible use-wear traces is burnt as well. A high level of heat exposure is also visible for the waste material, a normal result of the many potlids. However, when these are excluded the amount remains high at 57%. The presence of this amount of burnt artefacts, together with burnt organic material such as charcoal and bone, points to the presence of surface hearths at the site.

5.2.3 Site S3

General aspects

Several excavation campaigns (1972 - 1978), as well as the trenches S5 and S6, resulted in the artefacts discussed below. The core region of site S3 measures roughly 630 m² to 760 m², depending on the estimated extent of the layer. Of this area approximately 430 m² was excavated (57% - 68%) not including the parts of the trenches running into the creek.

Additional research was done at site S6 itself. The research was restricted to a ditch slope inspection and resulted in 3 artefacts ≥ 1 cm (see appendix 3 table 3.8).

The flint assemblage is divided into 9194 artefacts < 1 cm and 16171 artefacts ≥ 1 cm (table 5.2)[7]. The latter form 64% of all the flint artefacts found at the site and are defined as 11147 pieces of debitage material (68.9%), 1420 tools (8.8%), 721 bipolar pieces (4.5%), 468 artefacts with visible use-wear traces (2.9%), 40 other artefacts which are mainly fragments of polished flint axes (0.2%), and 2375 pieces of waste (14.7%).

More than half of the artefacts ≥ 1 cm (62%) are made from fine-grained flint without bryozoans. Fine-grained flint with bryozoans was used for 17% of the artefacts, making a total of c. 80% of fine-grained flint employed. Both medium- and coarse-grained flint types are rarely used varieties (1.5% or less). For the artefacts with visible

7 The sample of 856 artefacts analysed by Raemaekers (1999: 37-41) appears to have been lost.

use-wear traces, the use of fine-grained flint without bryozoans reaches as high as 70% whereas for the waste material this number lowers to 48% as a result of frequent heat exposure (see catalogue tables 2.6 and 2.7). More remarkable is the high percentage of medium-grained flint within the category of other tools (33%). This is mainly the result of the large amount of polished axe fragments. Of the 304 artefacts made out of medium- or coarse-grained flint, 27 are tools (9%); for the fine-grained flint types this is the same.

Heat exposure occurs with 4988 artefacts, or 31% of the larger artefacts, which obstructs the raw material determination of 3008 pieces (19%). Moderate heat exposure occurs most often. The debitage material is burnt as often as the tools; the high percentage of burnt borers is, however, a unique aspect here. The co-existence of heat exposure and high fragmentation rates is also visible, just as it was with the material of site S2. When the potlids are excluded from the waste material the high number drops to 39%, which is still rather high and is the result of the heat exposure of the numerous indeterminate fragments.

Debitage material
The debitage material is by far the largest category of finds at the site, consisting of 8186 flakes, 2583 blades, 211 rejuvenation pieces, and 167 cores.

Unidirectional debitage was used for most flakes whereas at least 641 specimens (8%) were detached using the bipolar technique. The fragmentation rate of the flakes is 53%. Up to 56% of the intact flakes are partially covered with natural surface such as cortex or patina, and 13% are defined as decortication flakes as they are covered for up to 75% or more of their surface. The intact flakes have average measurements of 16x14x4 mm and an average weight of 1.26 g.

The unidirectional debitage technique was also predominantly applied to detach blades. A limited number of 246 blades (10%) were the result of the bipolar technique. The majority of the blades may be described as 'irregular blades', since only 34% of the blades have a regular appearance with parallel edges and ridges. The fragmentation rate is just a bit higher than that of the flakes, namely 59%. The division of fragment types is roughly equally spread, with 35% medial parts occur, 32% proximal-medial parts, and 29% medial-distal parts. The 1061 intact blades have average measurements of 21x8x4 mm and an average weight of 0.99 g, making them smaller and lighter than on site S2. Up to 48% of the intact blades are partially covered with cortex or patina and for 9% this is 75% or more of their surface. It appears that the flake and blade fragments show fewer remnants of natural surface than the undamaged flakes and blades. As this also occurs at other sites, this is presumably not the result of the analysis.

The rejuvenation pieces are defined as 2 crested pieces, 184 striking edge rejuvenation pieces, 12 platform rejuvenation pieces, 2 core tablet, and 11 production plane rejuvenation pieces. The minimum dimensions of the rejuvenation pieces are 10x3x1 mm while the maximum dimensions are 50x38x13 mm; the resulting average is 21x13x6 mm. The rare crested blades measure 11x7x2 mm and 28x10x5 mm of which the latter is broken. Several of the striking edge rejuvenation pieces can be considered as blade-rejuvenation combinations, just as on site S2.

The cores form a group of 28 specimens with one striking platform, 17 with two opposing striking platforms, 7 with two crossed striking platforms, 20 with multiple striking platforms, 80 tested cores, 14 core fragments, and a battered core. This last one is so intensely covered with steps, hinges, and flake scars it sets itself apart from the others. There was a clear preference for fine-grained flint, and especially the variety without bryozoans. Nearly 90% of the cores are still partially to almost fully covered with cortex or patina. The intact cores are rather small with average measurements of 25x23x16 mm. Most have lengths up to 40 mm; less common are lengths between 40 mm and 55 mm. Almost none of the cores show any sign of systematic debitage or well prepared or maintained production planes. The striking platforms are often plain or consist of natural surfaces. Two or three, to a handful of detachments is often the yield of one core. The cores with applied striking platforms, i.e. not the tested cores, are rather ad hoc; still they have a more developed striking edge and more flake scars than the tested cores. The latter mostly have only one or two detachments per debitage attempt and have almost no platform preparation; suitable natural surfaces are often used as platforms. These tested cores are possibly even more ad hoc than the other cores.

One of the cores needs special attention as it is different from the others. It shows some similarities to the possible hammerstone found at the site (see below). Yet, the stacked steps and hinges together with battered edges give the impression of endless pounding in futile attempts to detach good quality flakes. The absence of random impact points suggests an interpretation as an apprentice's core.

The limited size of the cores, and also the limited size of most of the detachment scars on these cores, raises questions about the usability of these detachments as blanks for tools. But maybe these blanks were not the aim of the debitage attempts. One might think that, because of a certain strain on the flint supply at the sites, the raw material was largely valued and totally exploited as if each block of flint might possibly produce that final good flake. It also appears that every chunk of flint was good for practising debitage skills. Even more, some cores seem to be transitional forms between 'classic' platform cores and bipolar pieces. Maybe used up cores were recycled or transformed into bipolar pieces where possible.

Tools

The large collection of tools consists of 434 scrapers, 27 borers, 41 rounded pieces, 40 trapezes, 6 transverse arrowheads, 465 retouched pieces, 260 indeterminate tools or fragments thereof, and 143 retouched chips (figures 5.5 – 5.6). For the production of tools fine-grained flint is clearly valued, especially the variety without bryozoans. Most tool types have small amounts of medium- or coarse-grained specimens (1.2% - 2.8%). The exception is formed by the rounded pieces. Because of their general low number, two specimens form 5%. Just as the distribution of the raw material, the frequency of heat exposure of the tools is very similar to that of the debitage material.

The largest group of tools, the scrapers, can mainly be defined as end scrapers (84%), more often single than double. The scrapers are mainly produced on flakes, although of a high number of fragments the type of blank, whether flake or blade, could not be determined due to fragmentation. Still, the largest proportion of the tools is intact (67%). These intact scrapers form a cluster measuring between 8x9x4 mm and 32x26x8 mm, with three specimens being somewhat larger. The average dimensions are 18x16x6 mm. The end scrapers are technologically very similar although their morphological appearance varies, presumably due to the many different types of blanks. On the other hand, the double end scrapers are almost all produced on blades and therefore mostly have a regular appearance. The scraper fronts are almost all located distally and dorsally with a rectilinear, curved, or rounded delineation; oblique or irregular delineations appear less often. Specimens with retouched edges occur slightly more often than those with unretouched edges. The round scrapers are the rarest type of scraper, while the variety of shapes within the group of side scrapers is related to the diversity of the blanks and their shape. The latter show two types, retouches only on the lateral edge, or retouches covering proximal, lateral and distal areas. The fragmented scrapers are mostly larger scraper fragments and, less often, broken off scraper fronts. Here also, distal fronts appear more often than proximal fronts.

There seems to be a vague line between borers and rounded pieces at the site, yet the intensity of the retouched edges is used to set the two apart. The borers are mainly produced from blades and are as often broken as they are intact. The intact specimens measure between 19x9x2 mm and 45x21x12 mm resulting in an average of 27x12x5 mm. The borer's tip is mostly positioned distally and may have straight, convex or concave edges. The position of the retouches, whether dorsal or ventral, is very diverse. Rounding is visible on the tip of several borers.

The rounded pieces are also mainly produced out of blades, like the borers, yet the variety of other types of blanks is larger. Roughly half of them are intact and have minimum and maximum dimensions of 16x9x3 mm and 39x20x13 mm, the large crested blade excluded (see below). The location of the rounding is predominantly distal; only a handful of artefacts have a rounded butt or a combination of both. The rounding may be indistinct or well-developed and seems to be related to the general shape of the blank. The rounding of artefacts with a triangular cross section is often intense and appears to be the result of some sort of drilling activity; the wear-traces are visible on the edges and ridge and are most profound at the largest diameter of the tip, where friction would be greatest. The artefacts with a flatter appearance often have a less developed rounding at the tip which only covers the lateral edges. Whether this difference is related to the general shape of the blank or whether this is the result of a different use or activity could not be established with certainty. Yet, it is not inconceivable that the different shape of blank may have led to the selection for a different activity. One of the tools is special because of the unusual blank. It is a very long and thin crested blade (86x12x9 mm) made from fine-grained flint with bryozoans with rounding at the butt. More tools have rounded tips as well, such as borers, retouched flakes and blades, and a blade from a polished flint axe.

The arrowheads are mainly made up of trapezes and with a few transverse arrowheads[8]. Almost all of the arrowheads are produced on blades, in the other cases the blanks could be a flake or a blade fragment. Trapezes of the asymmetrical type occur the most with abrupt, direct retouches on both edges. The overall appearance and morphology of all trapezes varies a bit as the measurements, ranging from 10x8x1 mm to 23x17x5 mm, may suggest. Length-width ratios vary between 1.1 and 2.1 with an average of 1.4. The few transverse arrowheads differ slightly from the trapezes in both dimensions, from 10x10x2 mm to 18x19x3 mm, and in dimensional proportions as their length-width ratio ranges between 0.8 and 1.0 with an average of 0.9. Yet, their morphological variation is quite large, from almost rectangular, to irregular or regular with lightly concave edges.

Within the assortment of retouched pieces the retouched flakes are nearly as numerous as the retouched blades; other types of retouched artefacts occur less often. Mostly the retouched flakes are characterised by marginally

8 Deckers (1982: 39) mentions a "high triangular arrowhead, albeit of a disturbed area of soil, that does not resemble the equilaterally triangular arrowheads of Deiringen-Ruploh, but that is similar to the high triangular arrowheads from later phases of Rössen." Raemaekers (1999: 39) refers to this artefact as "a fragment of a triangular or leaf-shaped point". As the samples studied by Raemaekers could no longer be retrieved (see sections 5.2.2 and 5.2.3), this tool could not be analysed in this study. However, as the artefact was recovered from a disturbed area of soil (Deckers 1982: 39) the relevance of this arrowhead to the study at hand may be questioned.

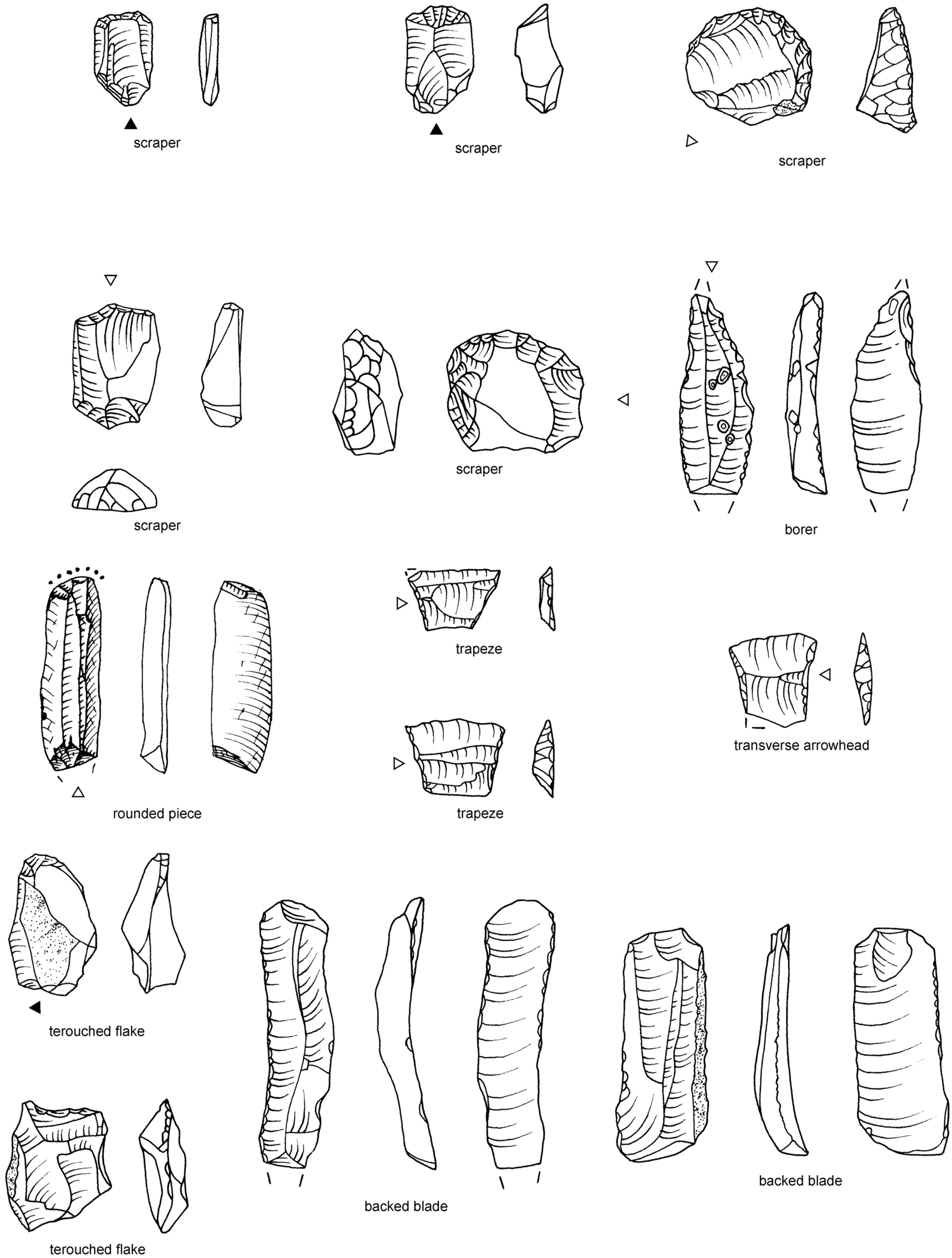

Figure 5.5 Overview of tool types present at site S3. Scale 1:1.

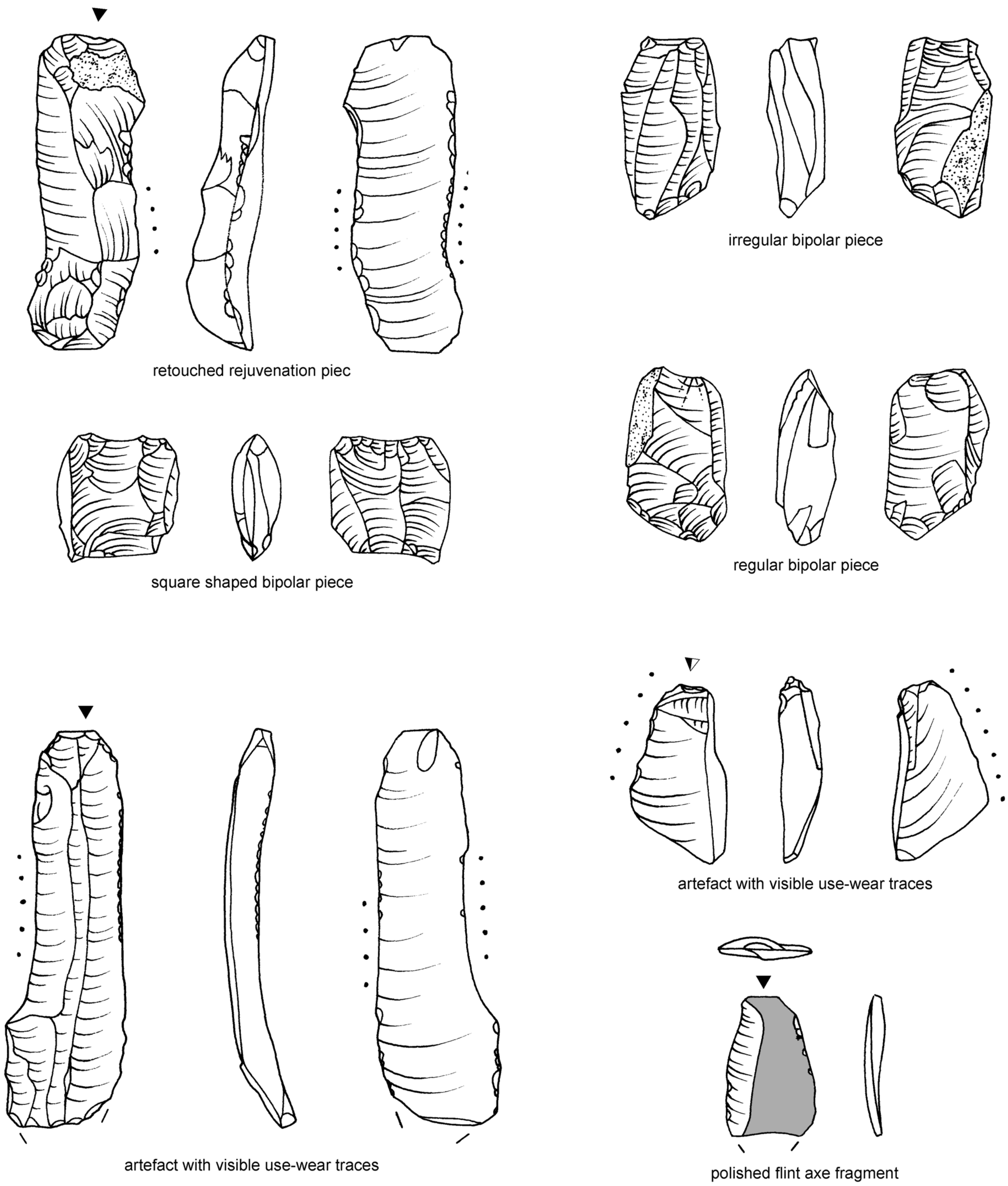

Figure 5.6 Overview of tool types present at site S3. Scale 1:1.

retouched edges or small retouches following the general curvature of the edge; these can be convex, rectilinear or irregular depending on their natural delineation. A concave delineation or denticulated, notched or truncated edge appears only now and again. The size of the retouch often appears to be related to the general size of the blank, therefore larger abrupt or semi-abrupt retouches occur less often as retouched flakes are generally rather small. The retouch is mostly on the dorsal face and often distally. Strangely enough when ventral retouches appear, this is often in relation to a convex ventral face, as if the choice to retouch either the ventral or the distal face may be related to the overall shape of the blank. Most of the retouched flakes are fully intact measuring between 10x6x1 mm and 42x35x16 mm. The average dimensions are 19x16x5 mm.

The retouched blades are predominantly backed blades, and to a lesser extent denticulated, notched or truncated blades. Mostly regular blades were used with two parallel edges and ridges. The working area is located on one or two edges, mostly on the dorsal face, less often on the ventral face. Combinations of one edge dorsally and the other ventrally retouched or even alternate retouches on one or both edges occur regularly as well. Sometimes additional retouches on the proximal or distal end occur, making them a transitional form between retouched blades and scrapers. The majority of the retouched blades are broken (79%); proximal-medial parts are most common, followed by medial parts and medial-distal parts. The average measurements of the intact blades are 30x14x4 mm, of the fragmented blades this is 25x14x4 mm. In general, the retouched blades are larger than the unretouched blanks and smaller than the blades with visible use-wear traces.

For the remaining retouched pieces many different types of blanks were used such as rejuvenation pieces, indeterminate fragments, frost flakes, nodules, cores, and even bipolar pieces. Their dimensions fall within the range of their unretouched counterparts, except for the rejuvenation pieces that are often the larger specimens. Retouches are often small, do not alter the general shape of the edges, and occur both dorsally and/or ventrally.

The remaining tools are predominantly different sizes of indeterminate tool fragments, and may be parts of truncated blades, trapezes, scrapers, or borers. The other tools are of an indeterminate type with all sorts of shapes and dimensions. They are most often produced from blades and may be some sort of projectile points, unfinished trapezes or poor attempts to produce them. Others are, however, some sort of battered cores or even multifunctional pointed tools.

Remaining flint material

The large group of bipolar pieces consists primarily of irregular pieces and to a lesser extent of regular and square shaped pieces; fragments occur as well. Most bipolar pieces are produced out of fine-grained flint, especially the type without bryozoans. Their sizes and shapes show a rather large variation with dimensions between 10x6x1 mm and 46x39x25 mm and averages of 24x18x9 mm. The remnants of cortex and patina still present on most of the bipolar pieces indicate that their current size is not that different from their original size as a nodule. A limited set of all three types is reoriented a quarter turn to start a new debitage axis.

For the artefacts with visible use-wear traces regular blades with parallel edges and one or two parallel ridges were clearly the preferred types of blank, just as fine-grained flint without bryozoans was the preferred type of raw material. Again, the high fragmentation rate of these blades is noteworthy (88%), with mostly medial parts (37%), and to a lesser extent proximal-medial (33%) and medial-distal parts (11%). The intact specimens range up to 69x26x14 mm, with average of 42x16x5 mm, whereas blade fragments reach up to 64x23x10 mm.

The polished axe fragments are mainly flakes, and rarely blades, cores, or other fragments; even a scraper and a retouched flake were produced out of an old axe fragment. The size and location of the polished areas varies per artefact, as do the general measurements, which range from 5x5x1 mm to 58x32x18 mm. Based on colour and texture, the fragments may belong to at least three and possibly even up to six different axes.

The other tools consist of a possible hammerstone and an artefact which has a complete patina. The first is, even if it is with some reservation, defined as a hammerstone because of the many impact traces around the edges. The many detached flakes make a definition as an apprentice's core, or a re-used core possible; the centripetal detachments, combined with the impact traces, are more in accordance with the use as hammerstone and in sharp contrast to the other cores found on the site.

The second artefact would have been defined as a single end scraper with one retouched edge if it was not totally rounded and covered with patina. This is most likely the result of exposure to the natural environment and possibly due to transport. It was however observed that miniscule pits, often seen in windblown patina, are absent. These characteristics suggest that the artefact was picked up from a site outside the area and brought back, perhaps with raw materials. It could be considerably older that the other tools on site S3 as it is completely patinated.

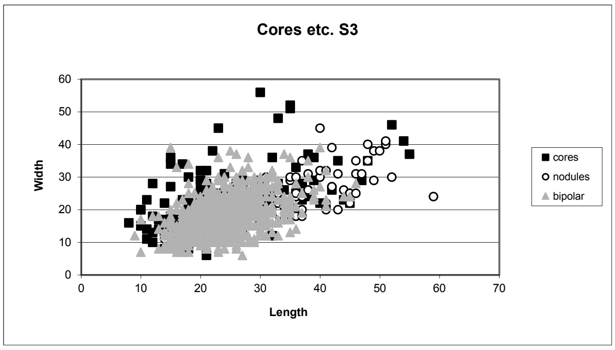

Figure 5.7 Total number of intact cores, nodules, and intact bipolar pieces of site S3. One nodule measuring 102x82x54 mm is not incorporated in this graph.

The waste material consists of indeterminate fragments, frost flakes, potlids and nodules. Multiple indeterminate fragments are damaged by fire, or are covered with frost fissures and Hertzian cones, often the result of exposure to natural environment and damage during transport. The nodules have minimum and maximum measurements of 14x9x5 mm and 59x45x34 mm, resulting in an average of 34x24x14 mm. This is roughly in correspondence to the cores on the site (figure 5.7), and to most of the flakes, yet not in correspondence to some of the larger blades. Only one nodule[9] is significantly larger measuring 102x82x45 mm and weighing up to 478 g.

The chips form up to 36% of the total flint assemblage at the site. Their weight varies from 0.01 g to 2.21 g with an average of 0.13 g. Approximately 26% of the chips may be microchips based on their weight. The number of artefacts per weight group increases gradually to the class of 0.05 g and decrease afterwards. Up to 71% of the chips are visibly not damaged by fire, 20% are, however, moderately exposed, 6% heavily exposed, and 3% lightly exposed. It was observed that some medium- and coarse-grained flint chips occur, of which a few may belong to one of the polished axes. Other chips may even be heavily burnt quartzite chips (see section 3.4, section 5.3.2 and catalogue section 2.2.3).

Conclusion

The flint assemblage at site S3 is predominantly made from fine-grained flint without bryozoans. Fine-grained flint with bryozoans takes up the bulk of the remainder of the artefacts. The border between the two types is very similar for the debitage material and the tools (c. 64% and 20%), even the very low percentages of medium- and coarse-grained flint are alike. For the bipolar pieces the percentage of fine-grained flint without bryozoans is comparable with the former two groups, yet the number of fine-grained flint with bryozoans is larger. This might be the result of less heat exposure that is only 15% for the bipolar pieces and 25% and 24% for the debitage material and the tools respectively, although one might presume that both types of flint would burn as easily. Another possibility is a less strict selection of the raw material, thus more flint with bryozoans, for the bipolar pieces. As the nodules on the site are 71% made out of fine-grained flint without bryozoans and 18% fine-grained flint with bryozoans, this may be true. For the artefacts with visible use-wear traces the selection gives a rather mixed signal. On one hand the percentage of fine-grained flint without bryozoans is relatively high (70%), on the other hand, the same applies to the medium-grained type of flint (3%).

The debitage material has a high percentage of flakes compared to blades (32% versus 10%) and a very low number of rejuvenation pieces and cores. The latter may partially be defined as on site S2. For some of the blades this certainly applies as they are not produced at the site because nodules, cores, and rejuvenation pieces are too small to produce such long blades (figure 5.9). For the flakes this is hardly the case (figure 5.8); only one or two flakes fall outside the measurements of the cores. All this indicates superiority in number, and a preference for using flakes as blanks, which might be a normal result as flake production was performed at the site. Blades, less common, are partially produced on-site and partially produced somewhere else. The bipolar pieces were possibly all made at the site as both nodules and cores are sufficient in dimensions.

All the cores are rather ad hoc. They nearly only have flake scars, certainly not systematic blade production, and still have large areas with cortex and patina. Noteworthy is that some cores are larger than the nodules from which they can be produced. Whether this implies that those large cores were brought to the site, just as the larger blades, cannot be substantiated. It is more likely that they were the first to be used, just because of their size.

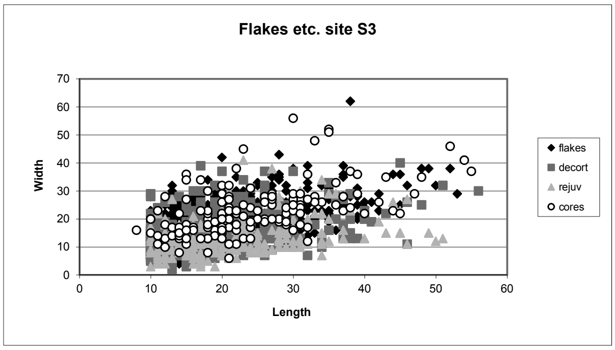

Figure 5.8 Total number of intact flakes, intact decortication pieces, including decortication blades, intact rejuvenation pieces, and intact cores of site S3.

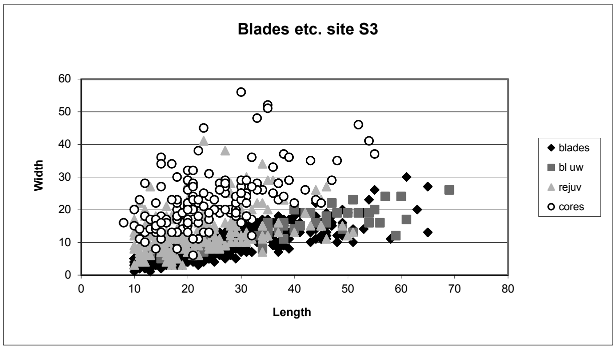

Figure 5.9 Total number of intact blades, intact blades with use-wear traces, intact rejuvenation pieces, and intact cores of site S3.

The low number of tools is even more visible because of the high percentage of debitage material. The waste material is also rather low, if it is compared to site S2. Alternatively, the waste material on site S2 might be exceptionally high. The toolkit is clearly dominated by scrapers and to a lesser extent by retouched flakes and blades, implying a domestic character of the activities and the site. All other types of tools are rare. The high number of tool fragments, both large and small, suggests intense usage of the toolkit and more extensive heat exposure.

The tools are nearly as often produced on blades as they are on flakes. The use of other types of blanks, such as rejuvenation pieces, cores, or frost flakes, is fairly high. All types of blanks being used may prove that flint was 'scarce'

9 This nodule is not included in figure 5.7.

and highly valued as nothing was wasted. Then again, the performed activities maybe did not require specific types of blanks. The predominance of flakes is also attestable with the debitage material. The artefacts with visible use-wear traces are the only category with a clear predominance of blades.

The scrapers are most often produced on flakes, but also on other types of blanks besides flakes and blades. This gives a more domestic feel to the toolkit. The dominant use of flakes is also visible in the retouched pieces where the specimens on flakes slightly outnumber the specimens produced out of blades. Some of these retouched flakes and blades may be described as transitional forms evolving towards scrapers. It appears that there is a gradual transition between the retouched pieces and scrapers.

The selection of blades adequate for use is similar as on site S2 where the largest blades were chosen to be used unaltered and slightly smaller blades were retouched, while the smallest blades appear to be generally unused; only two unretouched blades are larger than specimens from the other two categories.

Finally, the large crested blade with rounded tip is a curiosity or may even be some sort of trophy or proof of accomplishment or skill. It was clearly brought to the site ready-made as none of the artefacts on any Swifterbant site is large enough to produce this kind of blade. Also, the reduction technique, i.e. crested blade, is rarely seen at the sites.

The flint material shows a rather low to normal amount of burnt specimens. This is 31% of the artefacts ≥ 1 cm and 29% of the artefacts < 1 cm. The percentage is the same for the debitage material and the tools. The artefacts with visible use-wear traces are burnt less often than on sites S2 and S4. The waste material is exposed more often due to the presence of the potlids. When these are excluded, the number remains high with 39%. Moderate heat exposure occurs most often for all artefact categories.

5.2.4 Site S4

General aspects

The collected material is the produce of one old excavation (1974) and several new excavations (2004 - 2007). The cultural layer extends over an area of approximately 425 m² to 600 m². The excavated area of roughly 140 m² is approximately 23% to 33% of the cultural layer. This excavated amount does not include the parts of the trenches running into the back swamp or the creek.

The flint assemblage is made up of 2218 artefacts < 1 cm and 1484 artefacts ≥ 1 cm (table 5.3). The first group forms 60% of all the flint artefacts found at the site. The second group, the artefacts ≥ 1 cm, are defined as 918 pieces of debitage material (61.9%), 163 tools (11%), 52 bipolar pieces (3.5%), 78 artefacts with visible use-wear traces (5.3%), 3 other artefacts (0.2%), and 270 pieces of waste (18.2%).

Table 5.3 Total number of artefacts per typological category of site S4.

	Number	%	% ≥ 1 cm
Debitage material	**918**	**24.8%**	**61.9%**
Flakes	295	8.0%	44.8%
Flake fragments	363	9.8%	55.2%
Total flakes	***658***		***100%***
Blades	88	2.4%	40.0%
Blade fragments	132	3.6%	60.0%
Total blades	***220***		***100%***
Rejuvenation pieces	20	0.5%	
Cores	20	0.5%	
Tools	**163**	**4.4%**	**11.0%**
Scrapers	49	1.3%	
Borers	3	0.1%	
Rounded pieces	10	0.3%	
Trapezes	6	0.2%	
Tools on flake	14	0.4%	
Tools on blade	24	0.6%	
Tools on other blanks	5	0.1%	
Indeterminate tools	5	0.1%	
Indeterminate tool fragm.	44	1.2%	
Retouched chips	3	0.1%	
Bipolar pieces	**52**	**1.4%**	**3.5%**
Visible use-wear	**78**	**2.1%**	**5.3%**
Polished axe fragments	**2**	**0.1%**	**0.1%**
Pendant	**1**	**0.0%**	**0.1%**
Waste	**270**	**7.3%**	**18.2%**
Indeterminate fragments	101	2.7%	
Frost flakes	30	0.8%	
Potlids	133	3.6%	
Nodules	6	0.2%	
Subtotal ≥ 1 cm	***1484***	***40.1%***	***100%***
< 1 cm	**2218**	**59.9%**	
Total	**3702**	**100%**	

Fine-grained flint without bryozoans was preferred for more than half of the artefacts ≥ 1 cm (58%) whereas fine-grained flint with bryozoans is employed for 14%. Both medium- and coarse-grained flint are rarely used flint varieties (1% - 2%). For the bipolar pieces the use of fine-grained flint without bryozoans is as much as 73% (see catalogue tables 2.10 and 2.11). For the waste material this number lowers to 37% as a result of frequent heat exposure and thus hindrance for raw material type determination.

In total 607 artefacts ≥ 1 cm were exposed to heat (41%), hampering the raw material determination of 380 artefacts (26%). Moderate heat exposure occurs most often, light exposure less often. This 41% is a rather high number of artefacts ≥ 1 cm, whereas for the artefacts < 1 cm this is a more regular 29%. For the larger artefacts heat exposure is quite high for all artefact categories, especially for the waste material. When the potlids are excluded, this number remains high with 58%. As heat damage leads to fragmentation, it is no wonder flake and blade fragments are burnt more often than their undamaged counterparts. This also applies to the larger and smaller indeterminate tool fragments.

Debitage material

This category of artefacts outnumbers all other artefact groups within the set of ≥ 1 cm. The group includes 658 flakes, 220 blades, 20 rejuvenation pieces, and 20 cores.

The flakes were mainly detached using unidirectional debitage (93%); the remaining 46 flakes were detached using the bipolar technique. The number of intact flakes and damaged ones is nearly equal (45% versus 55%). The intact flakes have dimensions between 10x6x1 mm and 48x38x16 mm with average measurements of 17x15x4 mm and an average weight of 1.36 g. Up to 58% of these flakes show remnants of natural surface such as patina or cortex. The flakes covered for 75% or more are defined as decortication flakes (16%).

The majority of the blades were produced using the unidirectional technique (91%); only 20 blades show signs of bipolar detachment. Less than half of the unidirectional blades, and fragments thereof, are defined as 'regular blades' showing parallel edges and ridges (43%), the remaining part is produced less systematically and may be referred to as 'irregular blades'. The proportion of the intact versus the damaged blades is 40% versus 60%, which is just a bit higher than for the flakes. Medial fragments appear most often (53%), proximal-medial parts somewhat less (36%), and medial-distal parts the least (11%). The 88 intact blades have minimum and maximum measurements of 10x2x1 mm and 60x28x25 mm, with an average of 27x10x4 mm. Yet, they seem to divide into two dimensional clusters. The largest blades measure between 47x13 mm and 60x28 mm. The average weight of an intact blade is 1.95 g. Cortex and patina is still present on 43% of the intact blades, for the fragments this is 40%. Only three of the intact blades can be described as decortication blades (3%). It appears that the flake and blade fragments show fewer remnants of natural surface than the undamaged flakes and blades. As this also occurs on other sites, this is presumably not the result of the analysis.

It should be mentioned that a set of seven blades was found together in the same 0.25 m² excavation unit. Although these blades have sub-parallel edges, and often have converging ridges, their lengths reach up to 60 mm making them some of the largest blades at the site. The production process of these seven blades is very similar, yet somewhat different from the more regular blades at the site.

The rejuvenation pieces are nearly all striking edge rejuvenation pieces. Unfortunately, most of them are fragmented giving little reliability on the average measurements (18x12x4 mm). Of these, 65% are partially or fully covered with natural surface indicating the early stages of debitage or simply small nodule sizes. Notable are the two blade-rejuvenation combinations.

The group of cores is varied in type and in general morphology. They comprise 1 core with one striking platform, 6 cores with two opposing striking platforms, 2 cores with two crossed striking platforms, 2 cores with multiple striking platforms, 1 core with centripetal flake scars, and 8 tested cores. On all cores irregular flake scars often occur while blade scars seldom appear. If blade scars occur, they are always joined by flake scars and are detached from cores with two striking platforms. Mostly only a handful of detachments is visible, of which some are quite small. Combined with the fact that all the cores still have remnants of natural surface, this suggests that there was only the limited exploitation of the cores before they were abandoned. Furthermore, the average measurements of 31x27x16 mm imply the limited size of the used nodules, possibly contributing to the early discard of the cores. Only two larger nodules were used, measuring 71x55x20 mm and 77x73x49 mm. Without these, the average measurements are reduced to 26x23x14 mm. Often the natural, existing surface was used as striking platform, in other cases only minor preparation was discerned; a few were even lightly worked in a bipolar way.

Tools

The toolkit consists of 49 scrapers, 3 borers, 10 rounded pieces, 6 trapezes, 43 retouched pieces, 52 indeterminate tools or fragments thereof including 3 retouched chips (figure 5.10). The use of fine-grained flint without bryozoans is referenced for the production of tools, along with fine-grained flint with bryozoans. The percentages of medium- and coarse-grained flint are negligible (1%-2%), yet occur in all artefact categories except the bipolar pieces. The percentage of burnt tools is nearly as high as for the debitage material.

The group of scrapers, the most numerous type of tool on the site, are mostly end scrapers (95%), with or without retouched edges and more often single than double; only a couple of side scrapers occur. The scrapers are

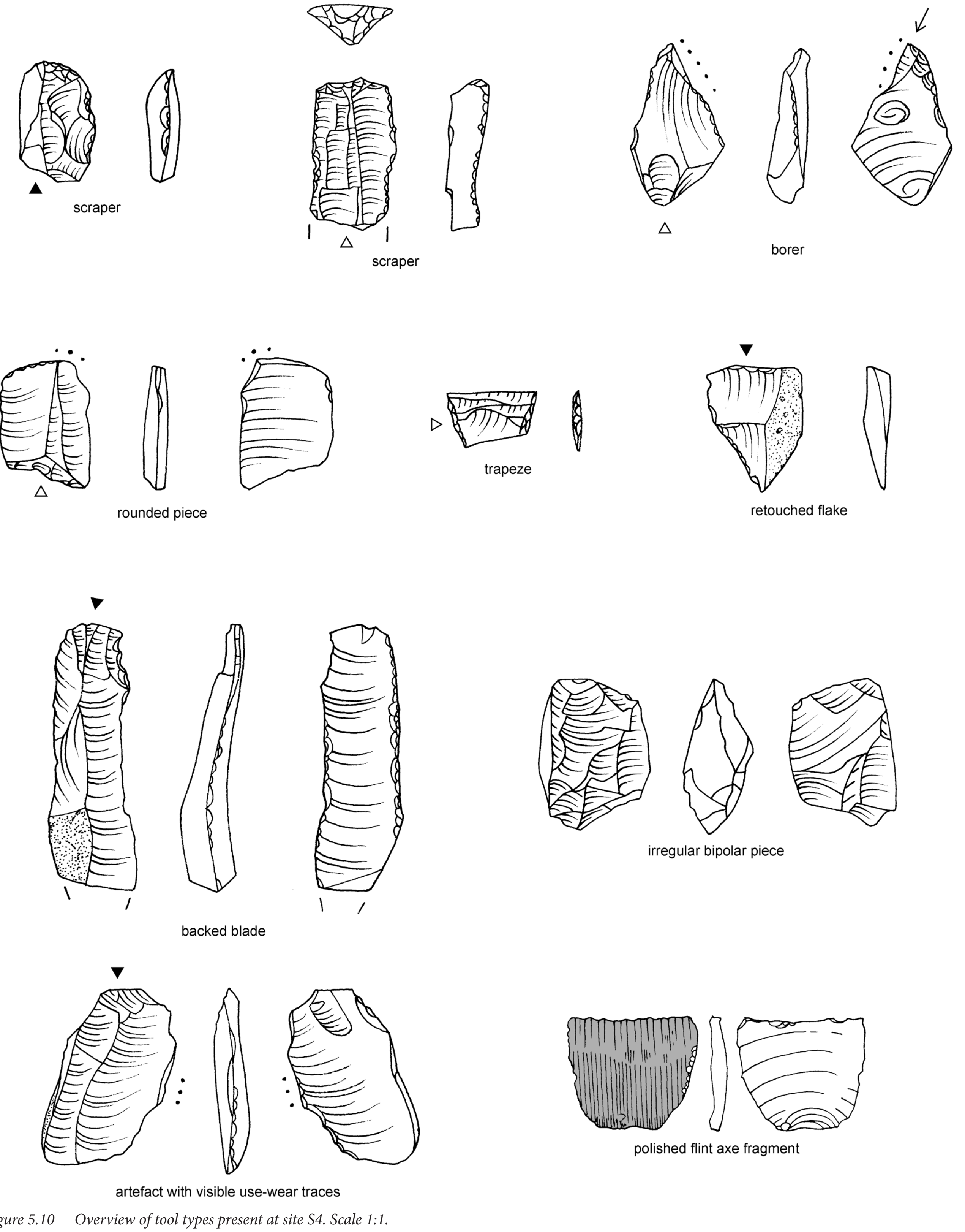

Figure 5.10 Overview of tool types present at site S4. Scale 1:1.

predominantly produced out of flakes, which creates a large morphological variation. Although they mostly have the same orientation and location of the scraper front, being distal end scrapers, it is hard to group them in more than twos, threes or fours. Only the few scrapers on blades have a more regular appearance. In general, they are rather small, varying between 11x9x2 mm and 30x29x12 mm, with average measurements of 19x16x6 mm. The fragmented scrapers are an almost equal combination of larger scraper fragments and broken off scraper fronts.

Here also, distal fronts with rectilinear or curved to rounded delineations appear most often.

The small set borers are all rather indistinct with small retouches on the edges and poorly pronounced borer tips. Although the three borers are morphologically a bit different, their dimensions are similar with averages of 29x13x7 mm. One of the tools is distinctly rounded.

The rounded pieces are a combination of blades and broken off tips. Most tools show one clearly rounded end; two rounded ends occur rarely. The blanks generally have a flat shape; none of them has a pronounced triangular cross section.

The only arrowheads occurring are asymmetrical trapezes, mostly made from blades. They almost all have direct, abrupt, short retouched edges. The only exception is the only trapeze produced out of a flake; it shows indirect retouches. Its general shape is also somewhat different from the others. The minimum and maximum dimension of the intact specimens varies between 14x9x2 mm and 16x14x3 mm, with an average of 16x12x3 mm. This results in a length-width ratio ranging from 1.1 to 1.8 resulting in an average of 1.4.

The retouched pieces are a mixture mainly consisting of retouched blades and retouched flakes. Other types of retouched blanks occur rarely. The retouched flakes mostly have rectilinear, concave or convex edges covered with mainly direct, short, abrupt or semi-abrupt retouches that follow the natural curvature of the blank. Only a handful have a slightly more irregular delineation such as a denticulated edge, a truncated edge, or a faintly notched edge. The dominant part of the retouched flakes is intact measuring between 13x11x2 mm and 39x30x11 mm. The average measurements are 25x20x6 mm.

The retouched blades are nearly all backed blades forming a homogeneous group. Their appearance is very alike as they are generally made from regular blades. Noticeable is that the larger blades and blade fragments also show gloss on the unretouched edges indicating a prior, secondary, or alternate usage. Only a few tools are produced on more irregular blades. Almost all blades are characterised by direct, abrupt and/or indirect (semi-) abrupt retouches along the edges. The greater part of the tools is fragmented (64%), medial parts are most common, followed by proximal-medial and medial-distal parts. The minimum and maximum measurements of the intact specimens vary from 8x8x2 mm to 49x21x8 mm with an average of 31x14x4 mm. In general, the retouched blades have a wider dimensional range than the blades with visible use-wear traces, especially in the smaller dimensional ranges, but are as large as them. The retouched blades are, however, smaller than the group of largest unretouched blanks (see above).

The remaining retouched pieces, made out of striking edge rejuvenation pieces, indeterminate fragments, and tested cores, generally have short and undeveloped retouching, making the pieces rather indistinct. Their dimensions fall within the range of their unretouched counterparts.

The limited set of tools of an indeterminate type is rather varied. They are all retouched blanks showing some resemblance to known tool types. One is a fragmented artefact broken through its notch that because of the atypical fracture cannot positively be defined as a microburin. Two other tools might possibly be some form of trapeze. The fourth has three retouched tips giving it the appearance of some sort of borer and the fifth might possibly be a hammerstone fragment.

Some of the remaining tools are smaller fragments such as retouched chips which are broken off tips or ends of tools < 1 cm. Another group are larger indeterminate tool fragments which originally could have been parts of scrapers, retouched blades, trapezes or even borers. The final set is damaged beyond recognition. These are parts of flakes or blades with some type of retouch but without special characteristics or identifiable morphological features. Two artefacts have long or invasive retouches, something rather uncommon at the Swifterbant sites. One is possibly a fragment of a tanged artefact.

Remaining flint material

The bipolar pieces are a combination of mainly irregular pieces and to a much lesser extent regular and square shaped pieces and fragments. Most were made from fine-grained flint without bryozoans (73%). Fine-grained flint with bryozoans is the only other type of raw material that could be identified. Up to 69% of the bipolar pieces are still partially covered with cortex or patina indicating that their current size is similar to their original size as a nodule. The intact pieces form a wide cluster with minimum and maximum measurements of 13x8x4 mm and 38x30x20 mm, and an average of 25x16x8 mm. Remarkable is a refit of three artefacts. Additionally, reorientation of the artefact with a quarter turn is observed in a few cases. As the original striking ridges often show stacked steps and hinges, this reorientation must have been an attempt to employ a new striking ridge in the hope to detach more flakes.

The artefacts with visible use-wear traces are mostly regular blades with one or two parallel ridges. The selection of fine-grained flint, especially without bryozoans was preferred. The fragmentation rate of these blades is high (82%) with a light dominance of proximal-medial parts over medial-distal and medial parts. The intact blades measure between 26x7x2 mm and 49x23x7 mm (average 35x14x4 mm), while the fragments reach as high as

52x33x13 mm. The blade fragment with a width of 33 mm was detached obliquely; its actual width is considerably less. A noteworthy feature is the rounding-off of two specimens. The rounding is located on the lateral edge contrary to the more common tip or fractured end of the artefact.

The polished flint axe fragments are a flake and a blade of two different flint axes. The flake fragment is rather wide, measuring 18x21x2mm, and has a light grey colour. The blade, also fragmented, measures 15x7x2 mm and might even have been detached from the side of the cutting edge. This flint type is also fine-grained without bryozoans but has a dark mouse-grey colour.

The remaining artefact needs special mention because of its rareness. The unfinished pendant made out of flint has dimensions of 39x14x6 mm which correspond well to the average measurements of the flat pebbles used for pendants on sites S2 and S3. It is possible that, because of the suitable dimensions, this flint pebble was chosen as a basis for an ornament. In contrast the raw material makes it unfit for this propose. The perforation attempt was presumably for that reason abandoned rather quickly.

The waste material is a combination of potlids, indeterminate fragments, frost flakes, and nodules. Barely any evidence of shattered cores or nodules was found. The nodules are covered with windblown patina and/or heavily rolled cortex. Their measurements range from 27x18x13 mm to 42x32x24 mm and have average measurements of 33x25x20 mm. This is in accordance with the size of the cores on the site (figure 5.11). Some of the flakes and the blades are clearly larger. Another exception is formed by two very large cores. As these are tested cores, covered for 50% to c. 100% with cortex, these are hardly anything more than nodules.

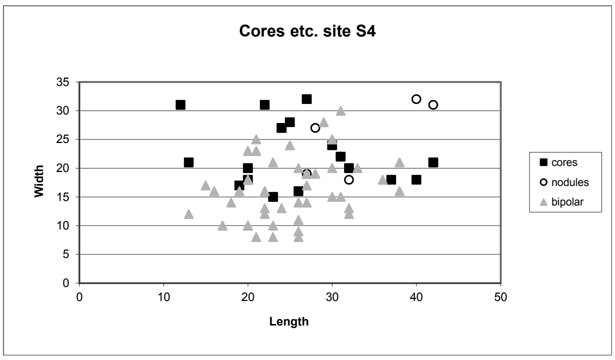

Figure 5.11 Total number of cores, nodules, and intact bipolar pieces of site S4. The two large cores are not included in this graph.

The collection of chips make up 60% of the total of artefacts recovered from the site. Only a limited number of 190 out of 2218 chips were weighed separately. Their weight ranges between 0.01 g and 0.95 g and has an average of 0.11 g. The analysis also revealed 78 possible microchips (41%). The group of 0.01 g is predominant and once heavier than 0.1 g the number per class decreases. Whether this is accurate or a distortion by the research method applied, remains unclear. A total of 71% were not exposed to heat whereas 18% was exposed moderately, 9% exposed heavily, and 2% exposed lightly. Furthermore, one chip was found in feature nr. 1 and 19 were recovered from the child's grave.

Comparison with Deckers' study from 1979

Deckers' article was based on the small excavation of 1974. A total of 244 flint artefacts were retrieved, of which two, a flake and a blade fragment with use retouch (Deckers 1979: 161), were found in the lower cultural layer. Deckers observed these two separate cultural layers only in the western part of the trench. The new research in 2008 revealed this lower layer to be the hoe-field. Deckers furthermore mentioned 8 cores, 112 flakes, 76 blades and 46 other pieces of flint material. These include 20 tools such as borers, scrapers, and retouched flakes and blades. Blades and flakes with traces of use are limited to 13. At that time no trapezes had been discovered. The large flake from a polished flint axe indicates the presence of flint axes on the site, and also on S3 (ibid: 161-162).

Today the material consists of 242 artefacts. Thus, two artefacts were lost over time. However, four tools from the drawings in the article could not be retraced. The cores are defined as cores with one or two platforms. Remarkable is that seven of these cores, currently defined as bipolar pieces, are not defined by Deckers as such. He only mentions that one core has a platform of 1 mm wide (ibid: 161).

According to Deckers, the material was vertically evenly distributed throughout the cultural layer (ibid: 164). The lower cultural layer is presumably not mentioned because only two flint artefacts were recovered. Horizontally the flint material clustered within in the 17-18 m E-W (ibid: 164-165). This is the area towards the centre of the dune. Down the slope towards the creek the material was less dense. All flint categories follow this same pattern and Deckers even saw a possible clustering of retouched flakes around the hearth (ibid: 165).

Conclusions

For the production of the flint artefacts at site S4 preference was given to fine-grained flint without bryozoans. The variant with bryozoans was used moderately. Only a few dozen artefacts were produced from medium- or coarse-grained flint (1%-3%). These types of raw material occur in nearly all artefact categories, except for the bipolar pieces. With the exclusion of one blade, the artefacts with visible use-wear traces would form the exception too. The proportion of fine-grained flint without bryozoans and fine-grained with bryozoans is nearly

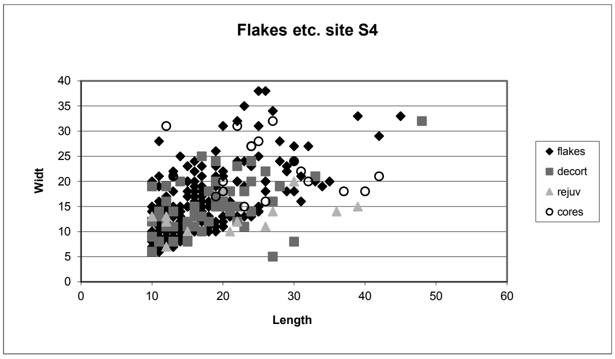

Figure 5.12 Total number of intact flakes, intact decortication pieces, including decortication blades, intact rejuvenation pieces, and intact cores of site S4. The two large cores are not included in this graph.

Figure 5.13 Total number of intact blades, intact blades with use-wear traces, intact rejuvenation pieces, and intact cores of site S4. The two large cores are not included in this graph.

identical for the debitage material, tools, and artefacts with visible use-wear traces (c. 62% versus 20%). The waste material contains a large amount of fine-grained flint without bryozoans compared to fine-grained flint with bryozoans; a feature also observed at sites S2 and S3. Thus, this is presumably a true image as there appears to be no reason why fine-grained flint with bryozoans would burn more easily than fine-grained flint without bryozoans, and consequently be a larger part of the many burnt artefacts.

Within the distribution of the artefact categories the low percentage of artefacts ≥ 1 cm is clear (40%). This is especially remarkable as most of the soil of the 2005-2006 excavations[10] is not even sieved. Within the material from excavation strips 8 and 9, which are sieved areas, the percentages are even 77% versus 23% for the artefacts < 1 cm and the artefacts ≥ 1 cm. Excavation strips 8 and 9 together hold more than 3 times as many artefacts than strips 0 to 7 together. If it is considered that strip 8 holds approximately 7.5% fewer artefacts than strip 9, and that strip 7 holds 90% fewer artefacts than strip 8, it may be presumed that roughly between 6700 and 7300 flint artefacts are missing.[11]

The debitage material has a high number of flakes compared to blades (18% versus 6%). Also the limited number of rejuvenation pieces and cores (both 0.5%) is similar to those from site S3. The number of rejuvenation pieces and cores is insufficient to produce the large amount of flakes and blades found at the site. Even more, part of the flakes and blades, the larger ones to be precise, were clearly not produced at the site as both rejuvenation pieces and cores are insufficient in length to produce them (figures 5.12 and 5.13). Additionally, some of the blades were systematically produced, a technique not observed on the cores at the site. On the other hand, the bipolar pieces may all have been produced at the site as all of them fall within the dimensional range of the nodules.

The cores are a collection of various types and various dimensions. However, they are all characterised by a handful of detachments and remnants of cortex or patina, even the two larger specimens. On half of the cores the natural surface was used as striking platform; the others show some form of minor preparation or the use of an existing flake scar from earlier detachments as striking platform. The cores show more or less random-shaped flake detachments, and if blades occur they are always in combination with flake scars implying they are more likely an unanticipated result rather than the result of systematic blade debitage.

When the artefacts < 1 cm are excluded, the proportions of the artefact categories ≥ 1 cm seem rather typical. The tools are dominated by scrapers, with about half the number of retouched blades. All other tool types are represented by a dozen of specimens or even less. The high number of tool fragments is partly explained by extensive heat exposure. Still, the percentage is rather high compared to sites S2 and S3.

For the tools an equal amount of flakes and blades was used, even though flakes outnumber the blades in the debitage material. For the artefacts with visible use-wear traces this selection of blades is even clearer. The use of other types of blanks is rather uncommon, as on site S2.

The scrapers are mainly made from flakes and to a lesser extent from blades. This dominance is equalled by the preference of retouched blades with the retouched pieces. As on site S3, there seems to be a gradual transition from the retouched pieces to the scrapers.

For the blades that were to be used unaltered, i.e. artefacts with visible use-wear traces, preference was given to systematically produced specimens that are slightly

10 The excavation trench was divided into 10 long strips of 0.5 m wide, of which the soil from strips 8 and 9 was integrally sieved over 2 mm meshes while strips 0 to 7 were excavated by shovelling (see section 2.7.4).

11 These calculations also take into account the differences in terms of percentages between lines 0 and 7.

larger than the specimens chosen to be transformed into retouched blades. Noteworthy is that the largest blades are blanks, with lengths between 50 and 60 mm. This is very different from the blade selection observed on sites S2 and S3.

The occurrence of burnt flint artefacts generally seems to be in conformity with the other sites. This is 29% for the artefacts < 1 cm and 41% for the artefacts ≥ 1 cm, which may be slightly elevated. It is, however, lower for the tools and the debitage material. On the other hand, more of the bipolar pieces were burnt, and even 58% of the waste material is burnt when the potlids are excluded.

5.2.5 Trenches S21-S24 and parcel H46

Parts of the material from this river dune were not studied in the same detail as the flint assemblages from the other sites for various reasons (see catalogue section 2.2.6). Some artefacts were only counted, some artefacts were submitted to a quick scan, and some artefacts were studied in detail. Therefore, the descriptions below will sometimes consist of two parts, namely general and detailed observations, often with their own tables. The detailed analysis comprises a randomly-chosen sample that incorporates parts of the flint assemblages of trenches S21-S24, consisting of 2085 artefacts (see catalogue table 2.14), in order to provide comparative data for the Neolithic dataset. The representation in terms of percentages is given in catalogue table 2.14 b.

General aspects

The artefacts from these trenches are the product of possibly two ditch slope inspections and several excavations (see sections 2.7.7 and 2.7.8). The surface of the river dune is estimated at 5275 m². The four trenches cover an area of c. 850 m² to 880 m² which is approximately 16% to 17% of the dune's surface.

The flint material from the different trenches forms a collection of roughly 12,000 artefacts (table 5.4). These can be defined as c. 1900 artefacts < 1 cm, c. 5300 artefacts ≥ 1 cm, and c. 4800 unspecified artefacts. The first two artefact groups were submitted to a quick scan, and some of these artefacts to a detailed analysis; the material from the third group was only counted. The latter will not be included in the analysis below.

The amounts and definition of the artefacts < 1cm and ≥ 1 cm that were counted and defined during the quick scan procedure, may deviate slightly from the actual number of surviving artefacts due to the nature of the procedure, but also from the sample studied in detail. The smallest artefacts comprise 10% of the material, the artefacts ≥ 1 cm form the remaining 90%. The latter consists of 1273 pieces of debitage material (40%), 823 tools (26%), 29 bipolar pieces (1%), 65 artefacts with visible use-wear traces (2%), and 991 pieces of waste (31%).

The raw material type was only studied in detail for the sample of artefacts. The analysis must therefore be seen as suggestive because not all artefact groups are represented in equal amounts.

During the counting of the artefacts it was noted that the flint types were the same as those from all the other sites in the Swifterbant area, with a dominance of fine-grained flint types and only a handful of medium- or coarse-grained flints. It was, however, observed that the flint with bryozoans contains a low to very low number of rather small fossils. One might say this is a better type of flint with bryozoans which suggests selective gathering of the material. Black or yellowish-brown discolouration of some of the artefacts occurs which might be the result of some sort of postdepositional processes. Rusty coloured spots must be interpreted as the effect of iron in the soil.

The detailed analysis revealed that fine-grained flint without bryozoans was used for half of the artefacts ≥ 1 cm (49.5%). The larger part of the remaining half is taken up by fine-grained flint with bryozoans (27%). Both medium- and coarse-grained flint types are used very rarely (together 1%). For the tools and the artefacts with visible use-wear traces the percentages of fine-grained flint without bryozoans are somewhat elevated, especially for the microliths; for the waste material it is lower.

Heat exposure was, just as the raw material type, only analysed for the sample. Of the artefacts ≥ 1 cm, up to 44% was exposed to heat. Moderate heat exposure was observed most (49%), while heavy and light exposure occurs progressively less (35% and 16% respectively). This rather high level of heat damage is maintained for the debitage material. Tools were exposed somewhat less and the high percentage of exposed waste material is the result of the potlids. When these are excluded, the percentage drops to 41%, which is still rather high compared to the other river dune sites. It was also observed that both the flake and the blade fragments were more often damaged by heat than their intact counterparts. For the artefacts < 1 cm the heat exposure is even higher (58%). Here heavy exposure highly outnumbers medium and light exposure.

The observations regarding the heat exposure of the artefacts entail a remarkable aspect. Some of the fine-grained flint artefacts from trench S21 have a glossy appearance on some of the dorsal flake scars and on their ventral face. This appears to be the result of debitage after light heat exposure. This might be the result of conscious heat treatment (Inizan et al. 1977, Purdy 1974, Peeters 2001c), although the limited number of artefacts showing this feature more likely point towards the re-use of an accidentally heated artefact. Whether this is the result of a Mesolithic event or whether this proves Neolithic

Table 5.4 Total number of artefacts per typological category of trenches S21-S24.

All material	S21	S22	S23	Unk. origin	Total	%
Debitage material	**539**	**656**	**2003**	**9**	**3207**	**44.5%**
Flakes & blades	475	586	1855	8	2924	40.6%
Rejuvenation	18	15	68		101	1.4%
Cores	46	55	80	1	182	2.5%
Tools	**120**	**339**	**448**	**9**	**916**	**12.7%**
Unspecified tools	82	283	447	9	821	11.4%
Microliths	38	56	1		95	1.3%
Bipolar pieces	**3**	**3**	**26**		**32**	
Visible use-wear	**11**	**40**	**20**		**71**	**1.0%**
Polished axe fragments			**1**		**1**	
Other		**1**			**1**	**0.0%**
Waste	**54**	**96**	**893**	**4**	**1047**	**14.5%**
Indeterminate fragments	19	23	377	2	421	5.8%
Frost flakes	8	24	97	1	130	1.8%
Potlids	26	40	407	1	474	6.6%
Nodules	1	9	12		22	0.3%
Subtotal ≥ 1 cm	***727***	***1135***	***3391***	***22***	***5275***	***73%***
	72%	91%	69%	138%		
< 1 cm	**278**	**115**	**1537**	**3**	**1933**	**27%**
	28%	9%	31%	19%		
Total	**1005**	**1250**	**4928**	**16**	**7208**	**100%**
Unspecified artefacts	**5066**	**4796**		**2241**	**12103**	
Grand total	**6071**	**6046**		**2241**	**19311**	

habitation on this Mesolithic site cannot be established at this point.

Debitage material

– General

It was the impression that both the flakes and the blades are rather small. Even though the distinction between blades and bladelets was not made during this Ph.D. research, many blades from this parcel may be considered as bladelets.

– Sample

This group of artefacts outnumbers all other groups, both within the sample as within the remaining material. The debitage material from the sample includes 1196 flakes, 619 blades, 34 rejuvenation pieces, and 71 cores.

The flakes were mainly detached by using the unidirectional debitage technique (99.6%); only 5 flakes were detached using the bipolar technique (0.4%). The number of broken flakes is nearly equal to the amount of intact flakes (47% versus 53%). The latter have dimensions between 10x6x1 mm and 41x46x22 mm with average measurements of 16x14x3 mm. It must be mentioned that the thickness of 22 mm is exceptional. It derives from a flake measuring 41x46x22 mm. Generally, thicknesses range from 1 to 10 mm. The average weight is 0.97 g. Approximately half of the intact flakes show remnants of natural surface such as patina or cortex. The 49 flakes covered for 75% or more are defined as decortication flakes. The flake fragments are less often covered with patina or cortex than the intact specimens.

Nearly all the blades were produced by the unidirectional debitage technique (99.8%); only 1 blade is detached in a bipolar way (0.2%). As said, the blades are mostly small and thin, often of a straight form. However, a limited number, at least 36 pieces or 6%, appear to be more systematically produced and have parallel edges and one, two, or three ridges; these are referred to as 'regular blades'. Most of the blades are broken (63%) with a majority of proximal-medial parts (48%), and to a lesser extent medial-distal (31%) and medial parts (21%). The intact blades have minimum measurements of 10x2x1 mm and maximum measurements of 78x30x12 mm. This leads to an average of 20x8x3 mm with an average weight of 0.64 g. Two of these maximum measurements come from the same blade. It is a large and wide blade, with parallel edges, of 78x30x10 mm (site S22, *no. 483*). The flint type might be of southern origin. Remnants of rolled or weathered cortex, in combination with different kinds of patina or not, occur on 43% of the intact blades and on 29% of the broken blades. Only 8 blades may be defined as decortication blades (3%).

The rejuvenation pieces are predominantly striking edge rejuvenation flakes and blades. Only a handful of platform rejuvenation pieces, core tablets, and production plane rejuvenation pieces were encountered in the sample. Most of these artefacts are intact and measure between 12x6x1 mm and 40x32x11 mm (average 22x13x5 mm), while half still show remnants of cortex or patina. Noteworthy are the two blade-rejuvenation combinations and the two, presumably, bipolar detachments.

The cores are a wide collection of types, forms, and measurements. The cores from the sample are defined as 17 cores with one striking platform, 15 cores with two opposing platforms, 9 cores with two crossed striking platforms, 4 cores with multiple striking platforms, 17 tested cores, and 9 core fragments. Small blade cores occur regularly, flake cores and combination cores are represented somewhat less. A handful of the cores are somewhat bipolar with a striking platform that is nearly reduced to a striking ridge; crushed or retouched striking edges occur as well. The number of detachments is often limited, although some cores can have up to five or six detachments per platform. The overall measurements of the intact cores also show a wide range of minimum and maximum dimensions of 11x10x9 mm and 45x54x47 mm (average 24x24x17 mm). Remnants of natural surface have been observed on most of the cores (81%).

Tools

- General

  Only a limited number of the 916 tools is specified by type, i.e. 93 pieces[12]. These will be discussed below in the sample. The bulk of the 823 remaining tools consists of retouched flakes, blades, and other retouched pieces, combined with scrapers, grouped together in large finds bags. Most microliths were recognised at the time of discovery and did not end up with the bulk of the tools. Instead, they were kept apart, some were shipped to the museum, and some were lost over time. Therefore, it is unclear whether their current number is representative.

- Sample

  These tools include 19 scrapers, 4 borers, 1 combination tool, 2 rounded pieces, 24 microliths, 1 trapeze, 38 retouched pieces, and 4 indeterminate tools or fragments thereof. The use of fine-grained flint is nearly exclusive. Fine-grained flint without bryozoans is preferred to fine-grained flint with bryozoans. The artefacts with visible use-wear traces show the same preferences, whereas the three bipolar pieces are produced out of fine-grained flint with bryozoans. Heat exposure is fairly prevailing (30%).

The scrapers are mainly end scrapers with retouched edges. Yet, the focus of the working surface seems to lie on the edges instead of the end. These are combined with one double scraper, one side scrapers, and a scraper fragment. Most of the scrapers are produced on flakes, rarely on anything else. Nearly all are intact and they have minimum and maximum measurements between 12x10x4 mm and 47x29x15 mm.

Of the four borers only one is intact. As so many are broken, it is hard to determine whether they are produced on a flake or blade. At least one is produced on a blade. Although it is lightly damaged, it can be defined as a double specimen. The tool measures 49x13x4 mm, whereas the others are all smaller.

The single combination tool is a scraper-borer. This rarely-seen tool was made from a blade and is broken. The surviving medial-distal part measures 38x14x5 mm.

The two rounded pieces are a flake and a blade, both intact, measuring 16x19x7 mm and 24x7x2 mm. The flake is lightly retouched and shows rounding of the edge. The blade is of the regular type with parallel edges and two ridges. This artefact shows rounding as well.

The relatively large number of microliths is defined as 2 A-points, 4 B-points, 1 C-point, 1 D-point, 3 crescents, and 3 triangles. Ten are broken and could no longer be defined by type. All but one are made from blades. The intact specimens measure between 9x3x1 mm and 24x7x2 mm, yet most have lengths between 15 mm and 21 mm. The only trapeze is rectangular and measures 17x12x3 mm. It is made out of a blade and is still intact.

The retouched pieces are a combination of 18 retouched flakes, 15 retouched blades, 4 indeterminate fragments with retouched and one retouched core. The majority of the retouched flakes are intact and measure between 17x12x3 mm and 35x34x15 mm. Half of the retouched blades are broken; the intact specimens have minimum and maximum measurements between 12x3x1 mm and 33x16x6 mm. Of the remaining retouched pieces three are undamaged; they measure between 24x14x8 mm and 34x28x11 mm.

12 No artefact drawings or plates have been included in this research as the analysed sample is considered to be too small to give a representative image of the assemblage present on parcel H46. It is also unknown how representative the sample is by itself, thus a selection of tools from this limited sample would possibly be suggestive making it incorrect to incorporate any type of plates.

The remaining tools are 3 indeterminate tool fragments and 1 smaller indeterminate tool fragment, i.e. retouched chip. Their only diagnostic feature is the presence of retouches, yet a clear typological definition is hard to make.

An interesting aspect of trench S22 should be addressed here, namely the presence of two heavily discussed artefacts (see catalogue section 2.2.6). The two transverse arrowheads that were first defined as grave goods (Meiklejohn & Constandse-Westermann 1978: 87) and later were tentatively interpreted as responsible for the death of the man in grave VIII on S22 (de Roever 1976: 217, 219), could not easily be traced during this investigation. Yet, when found it appeared that they are nothing more than two simple blades without any modifications, not arrowheads at all.

Remaining flint material
Of the bipolar pieces that have been found on the site three have been studied in detail. It appears they are different from those retrieved at the levee sites. All three pieces have a combination of a striking ridge and a striking platform, and may be seen as bipolar cores. On the levee sites such types are more of an exception than the rule. The three bipolar pieces are all intact and made from fine-grained flint with bryozoans. Only one shows remnants of patina. This is also the only regular bipolar artefact; the two others are of the irregular type. Their measurements range from 19x13x5 mm for the minimum dimensions to 27x14x11 mm for the maximum dimensions (average 23x13x8 mm).

The artefacts with visible use-wear traces from the sample are all different types of blades. Most of them are intact; the only two fragments are proximal-medial parts. The intact blades, and the intact striking edge rejuvenation blade, have minimum and maximum measurements of 36x12x4 mm and 63x17x6 mm (average 48x14x5 mm). Both fragments are smaller than these minimum measurements, yet both are clear examples of regular blades with parallel edges and two ridges. The other blades are two plunging blades, one long striking edge rejuvenation blade, and the final one has a double bulb.

The polished flint axe fragment is a proximal flake fragment. The artefact measures 18x13x1mm and was made from a grey coloured fine-grained flint type without bryozoans. The dorsal face is totally polished and shows striation marks.

The other noteworthy tool is a hammerstone. This tool, made of coarse-grained, grey coloured flint without bryozoans, was originally defined as a stone tool. The raw material is indeed of an intermediate type between flint and quartzite, and this might be the reason for its selection and use as a hammerstone. The artefact is broken in half, presumably as the result of impact and usage, and measures 72x48x32 mm. The convex edge is covered with impact traces and small and larger flake scars.

The little amount of waste material in the sample consists mainly of potlids and indeterminate fragments. The only nodule measures 82x54x51 mm and is totally covered with rolled cortex. These measurements are quite large compared to the cores, yet indicate the availability of such large nodules. Based on the size, all cores may have been produced at the site, they are indeed smaller than the nodule, yet more nodules should be measured to give a conclusive answer (figure 5.14).

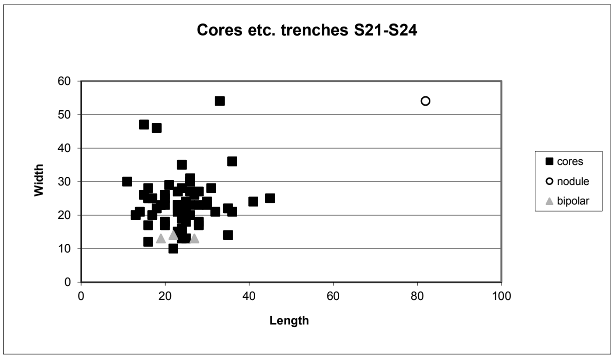

Figure 5.14 Total number of intact cores, nodules, and bipolar pieces of trenches S21-S24.

The chips make up 27% of the total number of artefacts excavated from the four different trenches. This is a low percentage compared to the other sites. Only 1564 chips have been studied in detail. They weigh between 0.01 g and 0.95 g which results in an average of 0.14 g. The best-represented group are the chips weighing 0.07 g. It appears the number of artefacts per weight class start low at 0.01 g, steadily grows to a peak at 0.07 g, and then gradually diminishes again. Nearly half of the chips show no traces of heat exposure (42%). The ones that are exposed are mainly heavily burnt (59%); medium exposure (35%) and light exposure (6%) occur much less often. It should also be mentioned that one of the chips shows a mirror-like gloss.

Cemetery and grave filling
The river dune was inhabitable from the Late Pleistocene – Early Holocene onwards, that is c. 8000 cal BC, to its inundation at c. 3700 cal BC (Raemaekers 2011b), indicating the possibility of habitation in both the Late Mesolithic and the Early and Middle Neolithic. The flint artefacts reveal a large Mesolithic fraction and a much smaller Neolithic fraction. However, the graves all have radiocarbon dates between c. 4510 - 4090 cal BC. Thus, Mesolithic habitation is attested by typical tools and debitage material, whereas Neolithic occupation was not only

attested by flint artefacts but also by a cemetery. The tools and debitage material found in the graves, which are most likely of Mesolithic origin, are therefore to be interpreted as accidental components of the grave fill and not as burial gifts.

Conclusions

Even though the material was not studied in the same detail as the other sites from the Swifterbant cluster, some aspects have been analysed in the sample sufficiently to describe the main characteristics of the flint assemblage. Other aspects can be characterised by some of the general observations.

As on all the other sites the preference for fine-grained flint without bryozoans is discernible. The proportion of fine-grained flint with bryozoans may, however, not be underestimated. The use of medium- and coarse-grained flint is limited to a bare minimum (1%) and present within the debitage material and the tools. For the only flint hammerstone on the site coarse-grained flint was chosen, presumably for functional purposes. The proportions of the two fine-grained flint types differ to some extent per artefact group. Seeing the low number of artefacts for some of these groups this is not so surprising. Yet, there are nearly always twice the number of fine-grained flint without bryozoans as there are fine-grained flint with bryozoans.

The dominance of artefacts ≥ 1 cm over artefacts < 1 cm (73% versus 27%) is rather distinctive. The artefacts ≥ 1 cm consist mainly of debitage material. Waste material takes second place and tools third place, yet their percentages do not differ much.

Within the debitage material a preference for flakes is clear. In the sample these are 66% versus 34%, which is nearly 2:1. The percentage of rejuvenation pieces and cores are rather low, yet, as some cores have five to six detachments per striking platform, this may not be such a low number. The size of the flakes and blades indicates that only the exceptionally large flake and blade could not have been produced out of the cores present at the site (figures 5.15 and 5.16). The other exception is formed by the regular blades with visible use-wear traces. Both their debitage technique and size suggest an 'off-site' production, i.e. a production elsewhere. The three bipolar pieces from the sample are at the smallest end of the measurement limits set by the cores. As these are indeed worked down cores, i.e. one end is still a striking platform, this is not surprising. The only nodule to have been measured, that is exceptionally large compared to the nodules and the cores on the other sites, indicates the existence of such raw materials. The only nodules roughly in the same dimensional range are found on sites S41 and S80-S82 (figure 5.14 versus 5.18 and 5.30). The largest nodule was however found on site S3 (figure 5.19 versus 5.7). It would appear that during the habitation on the dunes, i.e. the Mesolithic, as well as on the levee sites, i.e. the Neolithic, large nodules were available.

The cores show a wide variety in types, forms, and measurements; the amount of detachments even varies from only two or three to five or six per striking platform. It was observed that in the sample the blade cores outnumber the flake-blade and flake cores, while with the debitage material as a whole the flakes clearly dominate. This might be a discrepancy due to the fragmented analysis. Some of the blade cores are beautifully produced showing a series of straight, yet slender bladelets.

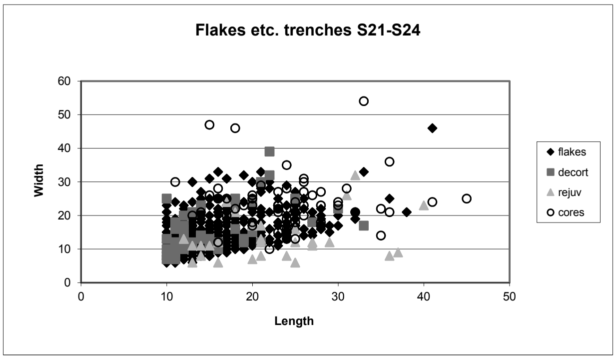

Figure 5.15 Total number of intact flakes, decortication pieces, intact rejuvenation pieces, and intact cores of trenches S21-S24 (sample).

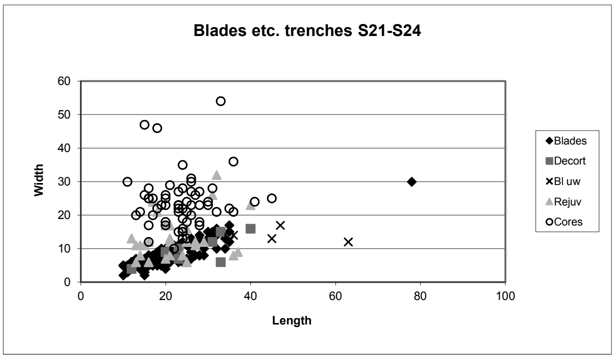

Figure 5.16 Total number of intact blades, decortication blades, intact blades with use-wear traces, intact rejuvenation pieces, and intact cores of trenches S21-S24 (sample).

Even though the tools were not all individually analysed, it was observed that the retouched pieces and the scrapers outnumber all the other types. It is, however, not clear whether the scrapers outnumber any of the groups of retouched pieces. In the sample the amount of scrapers and retouched flakes is nearly equal to the retouched blades; the amount of other retouched pieces is lower.

The sample also reveals that even though scrapers were mainly produced on flakes, and retouched flakes occur regularly, most of the tools were produced on blades. This is largely the result of the microliths. Also noticeable is the almost exclusive use of fine-grained flint without bryozoans for this tool type. The artefacts with visible use-wear traces were also nearly exclusively produced on blades. The only exception is a striking edge rejuvenation piece, yet this also has blade proportions, and is actually quite large. Thus, the largest examples have been chosen to be used unaltered.

Finally, it was argued that artefact nos. 107 and 108 were not transverse arrowheads and therefore not responsible for the death of the man in grave VIII on S22. They most likely landed in the grave along with the grave filling.

The amount of heat-damaged artefacts ≥ 1 cm is rather high compared to the other river dune sites (44%). Equally high numbers are discerned with the debitage material, and that of the tools is 30% which is still rather high in comparison. The same applies to the waste material so that, even when the potlids are excluded, there was still 43% of heat exposure. The chips also show elevated percentages of heat exposure.

5.2.6 Site S41

General aspects

The little information available for this site only reveals that the material is the produce of at least one ditch slope inspection. The designation of the finds bags suggest that the material was gathered at both sides of the ditch, thus at parcel G39 and at parcel G44. This would imply that the cultural layer of site S41 extents towards parcel G44 as well.

Material

In total 59 artefacts are currently known, these are 31 pieces of debitage material, 4 tools, 2 bipolar pieces, 1 artefact with visible use-wear traces, and 19 pieces of waste for the artefacts ≥ 1 cm and 2 artefacts < 1 cm (table 5.5).

The predominant flint types that have been identified are fine-grained flint with and without bryozoans. The latter is used most often (54%), not only for the debitage material, but also for the tools and the waste material (see catalogue tables 2.19 and 2.20). The one artefact with use-wear traces is produced out of fine-grained flint with bryozoans, while the only artefact out of medium-grained flint is one of the bipolar pieces. The general low number of artefacts makes this image more indicative than representative. For that matter, this applies to all of the comparisons below.

Heat exposure was observed with 44% of the artefacts ≥ 1 cm and the two artefacts < 1 cm are also burnt. Of the three exposure degrees moderate exposure occurs most often.

Table 5.5 Total number of artefacts per typological category of site S41.

	Number	%	% ≥ 1 cm
Debitage material	**31**	**52.5%**	**54.4%**
Flakes	12	20.3%	*63.2%*
Flake fragments	7	11.9%	*36.8%*
Total flakes	***19***		***100%***
Blades	5	8.5%	*55.6%*
Blade fragments	4	6.8%	*44.4%*
Total blades	***9***		***100%***
Cores	3	5.1%	
Tools	**4**	**6.8%**	**7.0%**
Scrapers	2		
Borers	1	1.7%	
Tools on blade	1	1.7%	
Bipolar pieces	**2**	**3.4%**	**3.5%**
Visible use-wear	**1**	**1.7%**	**1.8%**
Waste	**19**	**32.2%**	**33.3%**
Indeterminate fragments	7	11.9%	
Frost flakes	3	5.1%	
Potlids	5	8.5%	
Nodules	4	6.8%	
Subtotal ≥ 1 cm	***57***	***96.6%***	***100%***
< 1 cm	**2**	**3.4%**	
Total	**59**	**100%**	

Debitage material

This artefact category takes up more than half of the assemblage, whereas the debitage material itself is dominated by flakes. All but one of the flakes were detached by using the unidirectional debitage technique (95%). Most are still partially or fully covered with cortex or patina; one flake can be defined as a decortication flake. The intact, and the fragmented flakes for that matter, are all rather small measuring 26 mm in length or less. Their average measurements are 18x18x5 mm with an average weight of 1.42 g.

As for the flakes, the blades were mainly detached unidirectionally (89%), except for one that is the result of the bipolar technique. Of the unidirectionally detached blades two are produced more systematically, showing two parallel edges, of which one of even has a lip. Some of the blades have remnants of natural surface, although none can be described as a decortication blade. The intact blades measure between 21x9x2 mm and 40x16x10 mm and have average dimensions of 27x11x5 mm.

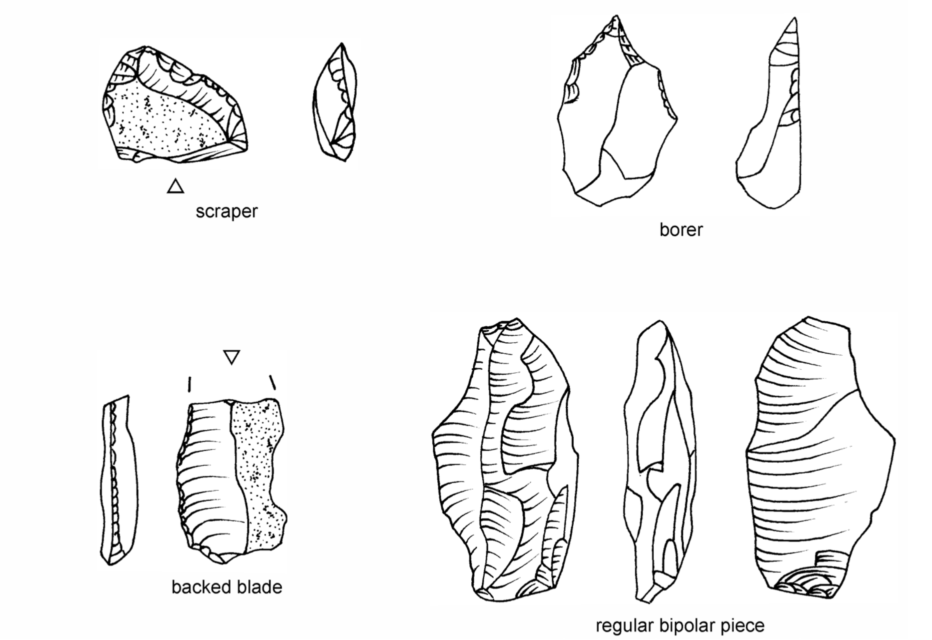

Figure 5.17 Overview of tool types present at site S41. Scale 1:1.

The cores are a somewhat exceptional collection measuring between 23x22x10 mm and 60x40x15 mm. The first has two opposing striking platforms and many stacked steps; the other two are flakes, a large and a smaller one, with small flake detachments. One of these even shows some use-retouch on the edge making it plausible that the detached distal flakes are the result of some sort of use. Then again, these retouches may indicate a different event.

Tools

The two scrapers have measurements of 20x15x5 and 22x16x6 mm (figure 5.17). The smallest is a side scraper; the other is a single end scraper with one retouched edge and a distal scraper front.

The borer is not the most convincing specimen, yet a tip is created by a set of ventral retouches. The tool measures 25x16x9 mm.

The retouched blade is a distal blade fragment of 23x15x4 mm with small retouches on the dorsal face. Both tools are made of fine-grained flint without bryozoans; only the borer is lightly exposed to heat.

Remaining flint material

Of the two bipolar pieces, one is regular with blade-like detachments and the other irregular with flake removals. Both were originally flake removals themselves and measure 33x29x12 mm and 37x18x8 mm.

The only artefact with use-wear traces is a proximal-medial blade fragment. It is one of the three regular blades found on the site and shows parallel edges and two converging ridges. As it is fractured (24x9x2 mm), it is uncertain whether it was longer than the unretouched blades; it

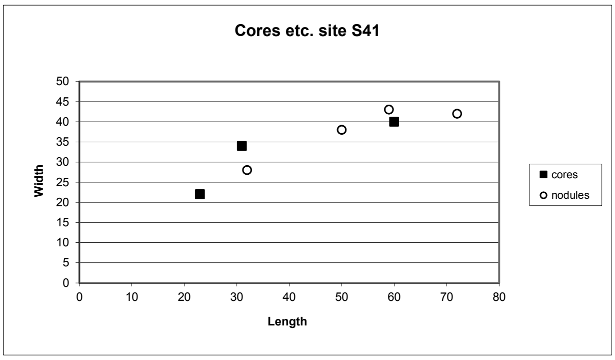

Figure 5.18 Total number of cores and nodules of site S41.

is in any case longer than most of them. Both use-retouch and gloss are visible on the edges.

The second largest group of material found at the site is the waste material. This group consists of seven indeterminate fragments, three frost flakes, five potlids, and four nodules. The four nodules measure between 32x28x9 mm and 72x43x34 mm for the minimum and maximum measurements, with an average of 53x38x24 mm, and are fully covered with weathered or rolled cortex and patina. Their size is rather large and certainly has been sufficient to produce the 'classic core' (fgure 5.18). The two cores on flakes, showing just a little natural surface, may have come from comparably sized nodules, although objections may be raised for the largest one.

The two chips or artefacts < 1 cm are both burnt. Although the damage prevented the flint type analysis of one of the chips, the weathered and granular surface, with sparkles glinting through, clearly set it aside from the other

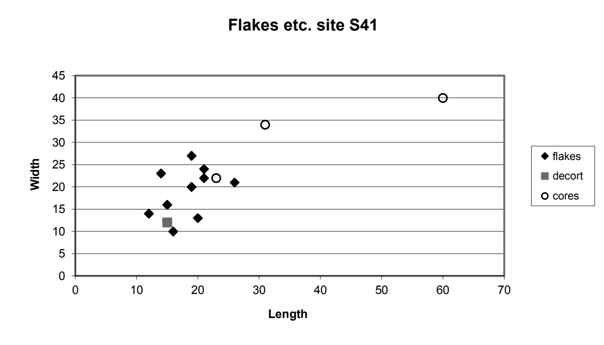

Figure 5.19 Total number of intact flakes, decortication pieces, intact rejuvenation pieces, and intact cores of trenches S41.

Figure 5.20 Total number of intact blades, decortication blades, intact blades with use-wear traces, intact rejuvenation pieces, and intact cores of trenches S41.

artefacts found at the site. This is one of those artefacts that might possible be made of something other than fine-grained flint (see section 3.4).

Conclusions
Even as this assemblage is a limited sample of what may be present at site S41, it might give some insight in the nature of the site by comparison with the other levee sites. The material appears to be in full conformity with the dominance of fine-grained flint without bryozoans, unidirectionally detached flakes and blades, and tools in the same spectrum. The dominance of the debitage material may be an image conjured by the limited extent of the sample; yet, it is similar to all levee sites, just as is the dominance of flakes over blades.

5.2.7 Site S51

General aspects
The artefacts at this site derive from one excavation only (1978). The site consists of four peripheral areas with only three remaining core regions. The largest middle area, with the three core regions, is c. 225 m² large of which c. 150 m² is core region. The trench covers two core regions and a part of the peripheral area. Roughly 120 m² was excavated which is c. 53% of the area.

The flint artefacts from this small excavation include 65 artefacts < 1 cm and 152 artefacts ≥ 1 cm (table 5.6). The latter forms up to 70% of all the flint artefacts found at the site and comprises 83 pieces of debitage material (55%), 27 tools (18%), 3 bipolar pieces (2%), 12 artefacts with visible use-wear traces (8%), and 27 pieces of waste (18%). Due to the rather low number of artefacts per artefact category, the percentages fluctuate rather easily making the following comparison and conclusions rather indicative than representative.

Up to 61% of the artefacts ≥ 1 cm are produced out of fine-grained flint without bryozoans, whereas fine-grained flint with bryozoans is employed for 16% of the artefacts.

Table 5.6 Total number of artefacts per typological category of site S51.

	Number	%	% ≥ 1 cm
Debitage material	**83**	**38.2%**	**54.6%**
Flakes	22	10.1%	*38.6%*
Flake fragments	35	16.1%	*61.4%*
Total flakes	***57***		***100%***
Blades	5	2.3%	*21.7%*
Blade fragments	18	8.3%	*78.3%*
Total blades	***23***		***100%***
Cores	3	1.4%	
Tools	**27**	**12.4%**	**17.8%**
Scrapers	13	6.0%	
Trapezes	2	0.9%	
Tools on flake	2	0.9%	
Tools on blade	5	2.3%	
Indeterminate tools	1	0.5%	
Indeterminate tool fragm.	2	0.9%	
Retouched chips	2	0.9%	
Bipolar pieces	**3**	**1.4%**	**2.0%**
Visible use-wear	**12**	**5.5%**	**7.9%**
Waste	**27**	**12.4%**	**17.8%**
Indeterminate fragments	10	4.6%	
Frost flakes	2	0.9%	
Potlids	14	6.5%	
Nodules	1	0.5%	
Subtotal ≥ 1 cm	***152***	***70.0%***	***100%***
< 1 cm	**65**	**30.0%**	
Total	**217**	**100%**	

Both medium- and coarse-grained flint are rarely used flint varieties (each 1.3%). Presumably none of these four medium- or coarse-grained artefacts were made from the same nodule. The quantity of fine-grained flint without

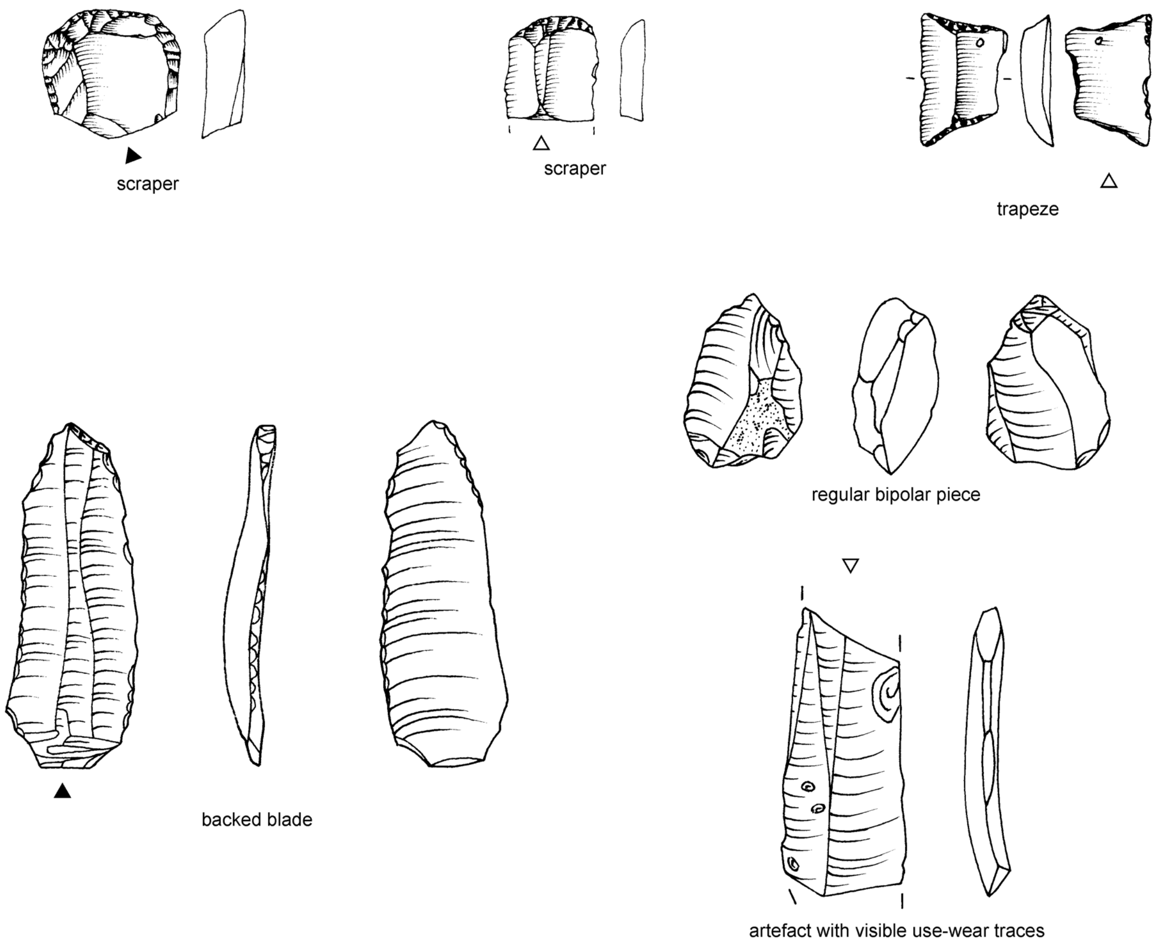

Figure 5.21 Overview of tool types present at site S51. Scale 1:1.

bryozoans is somewhat high for the artefacts with visible use-wear traces but comparable to site S3. With the debitage material it is also high compared to the other levee sites and low for the tools (see catalogue tables 2.23 and 2.24). This low number is also the case for the waste material which is partially the result of frequent heat exposure but also related to the high number of artefacts produced out of fine-grained flint with bryozoans. Then again, with such low numbers in general, percentages fluctuate easily under the influence of one or two artefacts. This is clearly the case with the tools. All the tools except for one trapeze are made from fine-grained flint with or without bryozoans. Yet, that single trapeze represents 4% of the tools.

Heat exposure was observed with 47 artefacts ≥ 1 cm (31%) which prevents the raw material determination of 30 artefacts (20%). Moderate heat exposure occurs most often, light exposure less often. The exposure is rather low for the debitage material and high for the waste material. With the exclusion of the potlids, the percentage lowers to 46%. The higher frequency of heat damage with flake and blade fragments compared to their undamaged counterparts is to be expected as heat exposure leads to fragmentation; just as with the indeterminate tool fragments.

Debitage material
The debitage material is the largest category of artefacts ≥ 1 cm at the site. A collection of 83 flakes, 23 blades, and 3 cores was found.

The flakes form the largest unit of artefacts within the debitage material. They were all unidirectionally detached, some even along a frost fissure or other internal fracture. The fractured flakes outnumber the intact ones with 61% versus 39%, which is a rather high fragmentation rate. The undamaged flakes have minimum and maximum dimensions of 11x7x1 mm and 43x31x10 mm resulting in an average of 17x14x3 mm. With the exclusion of the two large flakes, this number drops to 15x13x3 mm. The average weight is 1.16 g. Approximately half of the damaged and undamaged flakes are still covered with natural surface; two intact ones are even defined as decortication pieces (9%).

The blades were all detached in a unidirectional way. More than half of these were produced with a systematic blade technique (57%), while the remaining part may be described as 'irregular blades'. The fragmentation rate of the blades is high (78%); medial-distal pieces occur most often (55%), proximal-medial parts somewhat less (32%), and medial parts rarely (14%). As with the flakes, most of both the damaged and the undamaged blades are still covered, to some extent, with natural surface. However, none of them can be defined as decortication pieces. The intact blades range from 20x8x2 mm to 45x17x9 mm having average measurements of 33x13x5 mm. Their average weight is 2.41 g.

The little set of cores are all of different types, 1 core with one striking platform, 1 with multiple striking platforms and 1 tested core, and are worked rather irregularly without any form of core preparation. Natural surfaces are still present indicating the limited number of detachments. Only on one core are flake and blade detachments combined, even if they are all rather small and of the irregular type. The others are characterised exclusively by flake scars. The dimensions of the cores vary between 23x12x9 mm and 28x27x13 mm with an average of 25x19x11 mm.

Tools
The flint tools are a small collection of 13 scrapers, 2 trapezes, 7 retouched pieces, 5 indeterminate tools or fragments thereof (figure 5.21). Only one artefact was made of coarse-grained flint; all the others out of fine-grained flint with or without bryozoans. The tools are more often exposed to heat than the debitage material.

Of the predominant tool type, the scrapers, only a very limited number (31%) is intact and can be defined by type. These are mainly single end scrapers with retouched edges and a distally located, rounded scraper front. The used blanks are a bit more often (regular) blades than flakes. The intact scrapers measure between 13x12x5 mm and 17x18x5 mm, and have average measurements of 15x16x6 mm.

The scraper fragments are all broken off scraper fronts. They are rectilinear, curved, or rounded and some are rather thin. This makes the definition as scraper doubtful on one hand, but may be the reason for breakage on the other. It cannot be ruled out that they were used in a different way, for example a composite tool as with ‘mini-scrapers’, or for a different activity.

The two trapezes are asymmetrical and made out of regular blades. Both fine- and coarse-grained flint were used. Most edges show direct, abrupt retouches; only one edge is alternating. The dimensions of both trapezes are alike, being 17x11x3 mm and 18x14x3 mm, resulting in average measurements of 18x13x3 mm and an average length-width ratio of 1.4.

The retouched pieces are only represented by flakes and blades, of which the latter occur somewhat more frequently. The retouched flakes have minor edge alterations with short, abrupt or semi-abrupt retouches on the dorsal or ventral edges. The two specimens are largely intact and measure 10x13x2 mm and 25x33x8 mm.

The retouched blades are also characterised by minor edge alterations, mostly on the lateral edges. They are nearly all fragmented, mostly proximal-medial parts of regular blades with parallel edges and two ridges. The only intact blade measures 45x16x5 mm. The fragments have minimum dimensions of 33x16x3 mm and maximum dimensions of 53x23x10 mm, resulting in an average of 41x19x7 mm. Additionally, it might have been the intention to transform one of the blades into a borer. The tool has alternate retouches at its distal tip, yet the tip is unfinished. In general, the retouched blades are larger than the unretouched blanks but fall in the same dimensional range as the blades with visible use-wear traces.

The remaining tools are mainly smaller and larger tool fragments, such as retouched chips and parts of various tools. The last tool is of an indeterminate type; it is triangular shaped and retouched on three edges (13x13x4 mm).

Remaining flint artefacts
The bipolar pieces are two regular and one irregular piece. Fine-grained flint without bryozoans was used for the production of these artefacts. All three are still partially covered with cortex and/or patina suggesting their current size, ranging between 20x11x8 mm and 32x16x10 mm, is similar to their original size.

The artefacts with visible use-wear traces are predominantly made from regular blades which show traces on the lateral edges. Fine-grained flint without bryozoans was clearly preferred to produce these artefacts (75%). As with the blades and retouched blades, plunging specimens occur. Most of the blades are fractured (70%), mainly medial parts. The intact blades measure between 44x12x3 and 52x24x5 mm (average 42x17x4 mm), whereas the fragments are smaller measuring between 20x10x2 mm and 42x19x5 mm (average 30x15x4 mm).

The waste material comprises potlids, indeterminate fragments, frost flakes, and a nodule. The nodule measures

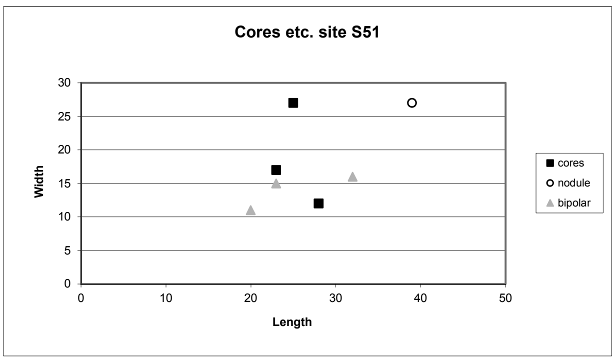

Figure 5.22 Total number of cores, nodules, and bipolar pieces of site S51.

39x27x16 mm and is covered with coloured patina and windblown gloss. The artefact is in conformity with the size of the cores and the bipolar pieces (figure 5.22); both may have been made from a nodule with such dimensions. Yet, the two larger flakes and several of the blades, with use-wear traces, retouch, or not, are clearly too large.

The chips make up 30% of the flint material found at the site. They weigh between 0.01 and 0.81 g with an average of 0.11 g. From the weight analyses it can be deduced that 32% of all chips might be defined as microchips. The group of 0.05 g forms the largest class; the lighter classes are present progressively less. Almost half of the chips were not exposed to fire, 32% was exposed moderately, 20 % was exposed heavily, and 3% was exposed lightly. Furthermore, heat discoloured 34% of the chips. Although flint type is not systematically registered for this type of artefacts, it was observed that one coarse-grained chip occurred.

Comparison with Deckers' study from 1979

As there has been no more excavation at site S51 since Deckers' study, all material should be included in his analysis. He speaks of 225 artefacts; 79 hand collected in situ and 146 from sieving. Thus, of both categories 4 pieces are missing. Of the depicted tools, three could not be identified within the current assemblage.

Deckers defines the artefacts as 84 flakes, 61 blades, 4 cores, and 76 other pieces of flint material. Within this set of artefacts, he defines 41 tools, including 27 specimens showing traces of use. When describing the cores, Deckers mainly noticed the blade and blade-like negatives on two of them. One may be the core described above; the other may be a lost artefact or even one of the bipolar pieces. The smaller dimensions of the flake scars on the two other cores made Deckers wonder about the usability of the produced flakes, an aspect also observed in this study.

Conclusion

Within the limited set of artefacts the high number of tools is discernible. This may be at the expense of the debitage material as the number of waste seems rather normal. The tools are clearly dominated by scrapers combined with a slight supremacy of retouched blades over all the other tool types.

The tools are nearly as often made from blades as from flakes; other types of blanks seldom occur. Yet, with the debitage material the flakes clearly outnumber the blades. This selective treatment of blanks is even more pronounced with the artefacts with visible use-wear traces. Due to the low number it is hard to tell whether the larger blades are the ones to be chosen for use as a tool. With the current specimens it certainly seems that way.

In total, 38% of the flint material was exposed to heat which appears to be a rather regular number. For the artefacts ≥ 1 cm this is 31%, while for the artefacts < 1 cm this is 55%. The latter is elevated compared to most other sites. Also 30% of the tools are exposed to heat, while for the debitage material this is only 20%. Noteworthy is the low number of artefacts with visible use-wear traces that show traces of heat exposure. The waste material shows a high number; even when the potlids are excluded this number remains high with 46%.

5.2.8 Site S61

It has been argued that most of the flint artefacts derive from the Mesolithic occupation layers, with a smaller number from the Neolithic layers (see section 2.6.15). As the finds context, i.e. the specific layer, of the majority of the artefacts ≥ 1 cm is lost, or was never properly registered, this can no longer be corroborated. Therefore we can only presume this to be correct.

General aspects

The material at site S61 was excavated in one season (1978). The river dune extends over an area of c. 3400 m². The trench covers an area of roughly 60 m² to 75 m², which is only 2% of the whole river dune.

The flint assemblage consists of 1043 artefacts < 1 cm and 794 artefacts ≥ 1 cm (table 5.7). This is roughly an equal

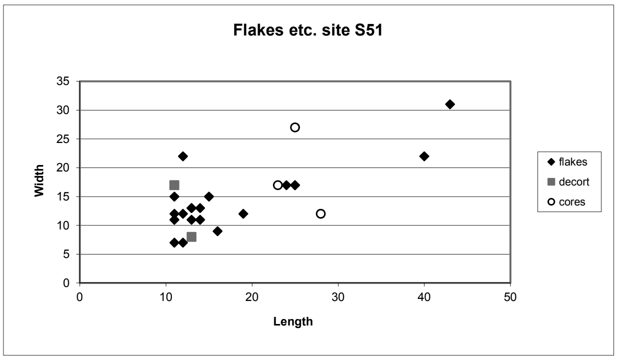

Figure 5.23 Total number of intact flakes, decortication pieces, and cores of site S51.

Figure 5.24 Total number of intact blades, intact blades with use-wear traces, and cores of site S51.

Table 5.7 Total number of artefacts per typological category of site S61.

	Number	%	% ≥ 1 cm
Debitage material	**621**	**33.8%**	**78.2%**
Flakes	311	16.9%	70.0%
Flake fragments	133	7.2%	30.0%
Total flakes	***444***		100%
Blades	47	2.6%	39.2%
Blade fragments	73	4.0%	60.8%
Total blades	***120***		100%
Rejuvenation pieces	20	1.1%	
Cores	37	2.0%	
Tools	**20**	**1.1%**	**2.5%**
Microliths	1	0.1%	
Rounded pieces	1	0.1%	
Tools on flake	2	0.1%	
Tools on blade	1	0.1%	
Tools on other blanks	2	0.1%	
Indeterminate tool fragm.	3	0.2%	
Retouched chips	10	0.5%	
Bipolar pieces	**1**	**0.1%**	**0.1%**
Visible use-wear	**4**	**0.2%**	**0.5%**
Waste	**148**	**8.1%**	**18.6%**
Indeterminate fragments	73	4.0%	
Frost flakes	47	2.6%	
Potlids	27	1.5%	
Nodules	1	0.1%	
Subtotal ≥ 1 cm	***794***	***43.2%***	***100%***
< 1 cm	**1043**	**56.8%**	
Total	**1837**	**100%**	

division of 57% and 43% respectively. The artefacts ≥ 1 cm are defined as 621 pieces of debitage material (78.2%), 20 tools (2.5%), 1 bipolar piece (0.1%), 4 artefacts with visible use-wear traces (0.5%), and 148 pieces of waste (18.6%). Most of the artefacts ≥ 1 cm were made of fine-grained flint without bryozoans (75%), whereas fine-grained flint with bryozoans was used for 17% of the artefacts. Together they form 92% of the material. Both the medium- and coarse-grained flints were rarely used (1%). The medium-grained artefacts, of which two probably come from the same nodule, are mainly debitage pieces; the only coarse-grained artefact is opaque-beige and is unique in shape. The preference for fine-grained flint without bryozoans is equally high for the debitage material as for the tools (c. 76%) (see catalogue tables 2.27 and 2.28). For the artefacts with visible use-wear traces the use of this type of flint is rather low, even if it is the result of the limited set of artefacts in that group, while for the waste material this is surprisingly high compared to all other sites. This is clearly the result of the limited number of burnt artefacts with this artefact category.

Heat exposure in general is limited as only 131 artefacts ≥ 1 cm or 16% were exposed. This obscures the raw material determination of 59 artefacts (7 %). Moderate heat exposure occurs most often, followed by heavy exposure and light exposure. This low number of heat-damaged artefacts is discernible in all artefact categories. Yet, percentage wise more tools were exposed to heat than debitage material, a rarely observed feature with the flint assemblage. The highest percentage of burnt artefacts is observed with the waste material; this is because of the potlids. When these are excluded the number drops to 21%. The previously-observed elevated heat exposure of flake and blade fragments compared to their undamaged counterparts is again clear at this site.

Debitage material

This category is by far the largest group of artefacts ≥ 1 cm present at the site. These consist of 444 flakes, 120 blades, 20 rejuvenation pieces, and 39 cores.

The debitage material is clearly dominated by flakes and these are most often intact (70%). Very rarely (1%), flakes were detached in a bipolar way instead of the general unidirectional way. Also, some evidence was found of detachment along internal fractures indicating battered cores or nodules. The minimum and maximum dimensions of 10x6x1 mm and 42x37x23 mm result in average measurements of 15x15x4 mm and an average weight of 1.44 g. The average length-width index of 1.1 only counts for the intact pieces. Both flakes and flake fragments are regularly covered with natural surface like patina or cortex, with the fragments somewhat less than the intact specimens. Up to 18% of the intact specimens can be considered decortication flakes. Some minor debitage errors occur like oblique detachments or plunging flakes.

All the blades are unidirectionally detached. Only a small number (25%) show signs of systematic blade production such as parallel edges and ridges, the others can be considered as 'irregular blades'. The blades are more often broken (61%) than they are intact, with mainly proximal-medial parts (38%), and to a lesser extent medial-distal (32%) and medial parts (27%). The remaining 3% were broken lengthwise. A fair part of the blades, and the fragments, are still partially covered with patina or cortex. Coverage for up to 75% or more was discerned with 11 specimens (23%) making them decortication blades. The dimensions of the intact blades vary from 10x3x1 mm to 52x23x15 mm with an average of 22x8x4 mm. The average weight is 0.95 g. Finally, a handful of plunging blades was observed.

The rejuvenation pieces are mainly a combination of striking edge, platform, and production plane rejuvenation pieces. As only one of them is fragmented their dimensions are very indicative. Their minimum dimensions of 11x7x1 mm and maximum dimensions of 33x33x13 mm result in an average of 21x17x6 mm. More than half of the specimens still show remnants of natural surface like patina or cortex indicating the generally small size of the nodules. Exceptional features observed are some blade-rejuvenation combinations and the detachment of a platform rejuvenation piece initiated from the back of the core.

It is not always easy to assign the cores to a specific subtype as most are rather irregular and knapped unsystematically. Still, five different core types, with one, two, or three striking platforms, have been distinguished, of which the tested cores are the most numerous. The striking platform is often a naturally-formed surface like a frost flake scar or a surface covered with patina. When the platform is newly created it can sometimes be facetted. Nearly all cores still have remnants of natural surface covered with cortex or patina indicating the limited number of detachments and the small size of the used nodules. These cores measure between minimum measurements of 15x12x6 mm and maximum measurements of 45x40x35 mm with an average of 29x26x18 mm. Only a handful of cores show blade scars, none of systematic technique; all the other cores have flake scars. Finally, three tested cores may possibly have been put on an anvil during their debitage; one shows splintering, the other two small flake scars. As no other characteristics of bipolar production are present, like a striking ridge or lenticular cross section, it cannot be ruled out that the opposing impact traces are the result of the reorientation of the core.

Tools

The limited number of tools is unequally defined as 1 microlith fragment, 1 rounded piece, 5 retouched pieces, and 13 larger or smaller tool fragments (figure 5.25). The tools are predominantly produced out of fine-grained flint without bryozoans; no medium- or coarse-grained flint was used for this artefact category. It was also observed that the tools are more often exposed to heat than the debitage material.

The only microlith fragment is a small pointed tip measuring 10x5x2 mm which presumably is a triangle fragment. The rounded piece is exceptional in shape and raw material. Its shape reminds me of a *briquette* or *bikkel*. One tip is lightly rounded, at the other end several chips or small flakes have randomly been chipped off. The majority of tools are, however, retouched pieces produced on various types of blanks. Parts of their edge are covered with short, abrupt or semi-abrupt retouches, yet these do not alter the general shape of that edge. Proximal retouch, often on the dorsal face of the left edge, an occasionally recorded feature with both retouched blades and blades with visible use-wear traces, was also observed at this site. The larger indeterminate tool fragments mostly have a truncation of short, abrupt retouches as if they were parts of truncated blades or transverse arrowheads. The smaller fragments are parts < 1 cm of other tools; these can also be microlith fragments or re-sharpening retouches.

Remaining flint artefacts

Typologically speaking, only one bipolar piece was recovered from this site. The artefact, measuring 24x16x12 mm, is rather irregular in shape with a striking platform and a striking point. It was made of fine-grained flint with bryozoans and still shows some remnants of rolled cortex.

Additionally, two of the above mentioned tested cores (*nos. 188 and 294*) may show the application of the bipolar technique. Technically speaking they are tested in a bipolar way meaning that they rested on an anvil when they were struck from above. Unfortunately, because they are only tested specimens, they lack other characteristics of bipolar pieces like a striking ridge, striking point or lenticular shape. This implies that tested bipolar cores cannot be defined as bipolar pieces as such. Even more, it cannot be ruled out the detachments are not the result of the reorientation of the core.

The artefacts with visible use-wear traces were produced on flakes and frost flakes. They all show minor traces on their edges, like small (irregular) retouches and gloss, both in different proportions and intensities. Fine-grained flint is preferred, although medium-grained flint occurs as well. The measurements of the intact flakes are 29x20x4 mm and 31x25x7 mm.

The waste material is made up of indeterminate fragments, frost flakes, potlids, and a nodule. A few indeterminate fragments may be the result of shattered cores or nodules, some even from the same nodule. Minor damage or light testing is visible on some of these fragments. The nodule measures 38x25x18 mm and is also lightly damaged or tested as several chips are detached. This nodule is smaller than some of the cores, yet falls within the measurement range (figure 5.26). The bipolar piece is rather small as well and may have been produced at the site since it is both smaller than the nodule and nearly all the cores.

The chips make up 57% of the flint artefacts retrieved at this site. The minimum weight for a chip here is 0.01 g and the maximum is 1.13 g resulting in an average of 0.08 g. Up to 56% of these chips may even be microchips as they weigh between 0.01 and 0.05 g. The group of 0.01 g occurs most often and the number of specimens per class diminishes progressively as the classes increase in weight. Most of the chips were visibly not damaged by heat (81%), only

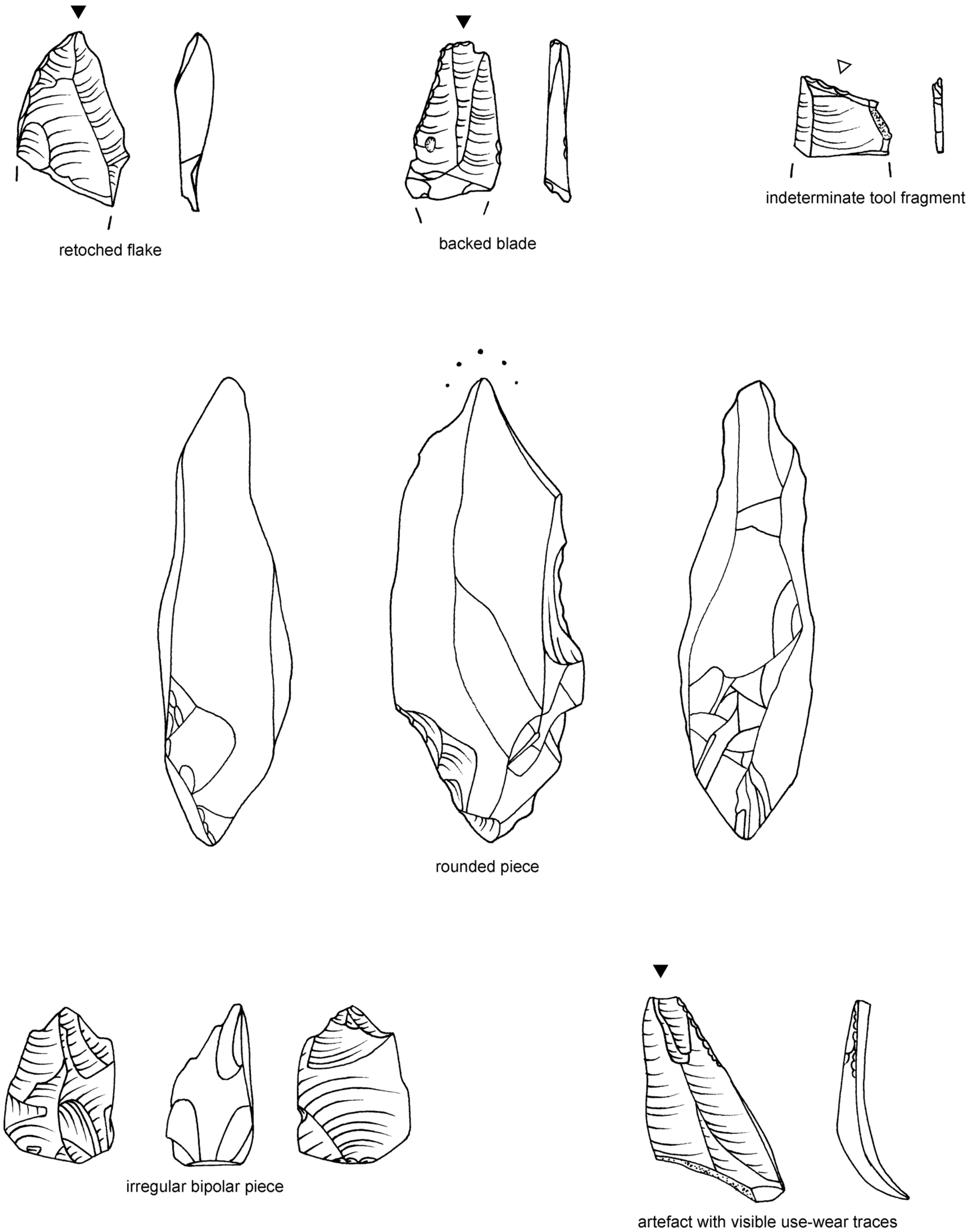

Figure 5.25 Overview of tool types present at site S61. Scale 1:1.

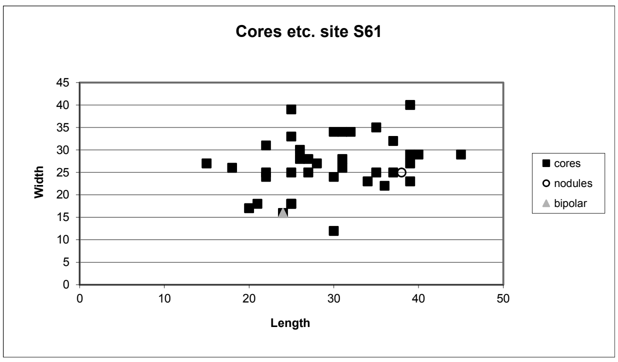

Figure 5.26 Total number of cores, nodules, and bipolar pieces of site S61.

10% was exposed moderately, 8% was exposed heavily, and 1% was exposed lightly. This heat exposure resulted in the discolouration of 109 or 11% of the artefacts. It was observed that only one chip was not made from fine-grained flint but from medium-grained flint.

Conclusion

The excavation at this river dune uncovered only a little part of the site. Therefore, the following interpretation should be regarded as indicative and not representative.

For the production of the artefacts fine-grained flint without bryozoans was clearly preferred. Fine-grained flint with bryozoans is used far less whereas medium- and coarse-grained flint is extremely rare. Equal amounts of fine-grained flint without bryozoans were used for the debitage material and the tools alike. However, because of the overall low number of tools this image might not be as representative as it seems at first sight. Alternatively, the waste material also shows a rather high percentage of fine-grained flint without bryozoans.

More remarkable is the low number of heat-damaged artefacts. Only 16% of the artefacts ≥ were exposed to heat, a tendency clearly visible with the waste material.

When artefact categories are compared, the very high number of debitage material and very low number of tools is immediately discernible. Even more, the debitage material is clearly dominated by flakes (24%). The ratio between blades and flakes is 1:3.5 as blades only make up 7% of the flint assemblage. Both the rejuvenation pieces and the cores are rather low in number as well. The size of most of the flakes and blades fall within the dimensional limits set by the cores, implying they might all have been produced at the site (figures 5.27 and 5.28). Only three blades are somewhat larger, and may consequently not be produced on the site. Only one of these three blades is of the regular type. Additionally, the low number of blade scars on the cores makes one wonder about the local or non-local production of the other blades.

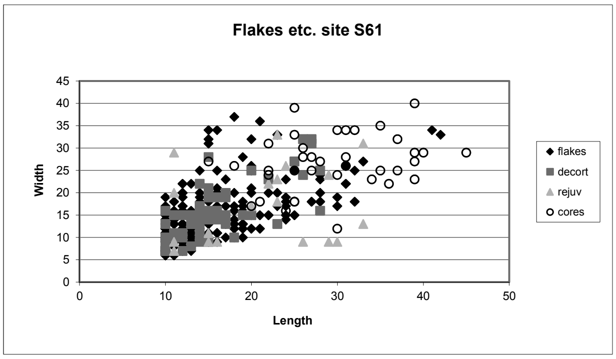

Figure 5.27 Total number of intact flakes, decortication flakes, rejuvenation pieces, and cores of site S61.

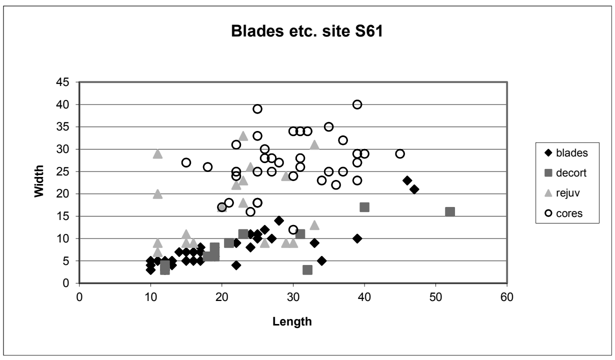

Figure 5.28 Total number of intact blades, decortication blades, rejuvenation pieces, and cores of site S61.

The cores show a wide variety of types and may be described as rather unsystematic. Core preparation is often very limited, or even absent, as natural surfaces are used when they were available and suitable, indicating opportunism. The presence of cortex and patina suggest a limited number of detachments per core which are almost exclusively flakes. Two cores hint at being struck on an anvil, although only one true bipolar piece was identified in combination with a few bipolar flakes.

One of the most striking aspects of the toolkit is the total absence of scrapers, a tool type so common on all the other sites, both levee and river dune. Alternatively, retouched pieces occur predominantly. Microlith fragments indicate Mesolithic habitation whereas the rounded piece seems to be a *bikkel* "avant la lettre".

The dominance of flakes over blades is also clear for the tools and the artefacts with visible use-wear traces. Even more, the latter show a total absence of blades. Their dimensional range therefore falls well within the limits set by flake and blade blanks alike; they are even on the small side. On all other sites, and the levee sites in particular, the artefacts with visible use-wear traces are predominated by blades, and often by the largest specimens.

The low percentage of heat exposure observed with the larger artefacts persists for the artefacts < 1 cm. The dominance of moderately exposed artefacts over heavily and lightly exposed specimens is similar as well.

5.2.9 Sites S80-S84

General aspects

The flint material comprises 62 artefacts < 1 cm and 171 artefacts ≥ 1 cm which is 26% and 74% of the material respectively (table 5.8). The artefacts ≥ 1 cm are classified as 108 pieces of debitage material (63%), 18 tools (11%), 1 artefact with visible use-wear traces (1%), and 44 pieces of waste (26%).

Most of the artefacts ≥ 1 cm were made out of fine-grained flint without bryozoans (70%). Fine-grained flint with bryozoans was used far less (16%) whereas medium-grained flint occurs only three times (2%). No coarse-grained flint was observed. The preference for fine-grained flint without bryozoans over fine-grained flint with bryozoans is attested for all artefact categories with roughly the same percentages (see catalogue tables 2.31 and 2.32). The only artefact with use-wear traces forms the exception.

Of the artefacts ≥ 1 cm 39 artefacts, or 23%, was exposed to heat. Because of this, the analysis of the raw material type of 20 artefacts could not be undertaken. Moderate heat exposure is observed most often, while heavy and light exposure occur gradually less. This low frequency of heat damage is discernible throughout all artefact

Table 5.8 Total number of artefacts per typological category of sites S80-S84.

	Number	%	% ≥ 1 cm
Debitage material	**108**	**46.4%**	**63.2%**
Flakes	48	20.6%	*78.7%*
Flake fragments	13	5.6%	*21.3%*
Total flakes	***61***		***100%***
Blades	16	6.9%	*69.6%*
Blade fragments	7	3.0%	*30.4%*
Total blades	***23***		***100%***
Rejuvenation pieces	7	3.0%	
Cores	17	7.3%	
Tools	**18**	**7.7%**	**10.5%**
Scrapers	4	1.7%	
Microliths	2	0.9%	
Tools on flake	2	0.9%	
Tools on blade	3	1.3%	
Tools on other blanks	3	1.3%	
Indeterminate tool fragm.	2	0.9%	
Retouched chips	2	0.9%	
Visible use-wear	**1**	**0.4%**	**0.6%**
Waste	**44**	**18.9%**	**25.7%**
Indeterminate fragments	16	6.9%	
Frost flakes	13	5.6%	
Potlids	10	4.3%	
Nodules	5	2.1%	
Subtotal ≥ 1 cm	***171***	***74.1%***	***100%***
< 1 cm	**62**	**25.9%**	
Total	**233**	**100%**	

groups. Even the number of damaged waste is rather low. This number reduces even more to 18% if the potlids are excluded, which is in concordance with the other two artefact groups. It may also be established that the intact flakes were exposed more often than the broken specimens and that for the blades this is the other way round.

Debitage material

The debitage material is the largest artefact group at the site. It even outnumbers the artefacts < 1 cm. The material is a collection of 61 flakes, 23 blades, 7 rejuvenation pieces, and 17 cores.

The flakes are predominant within the debitage material and the remainder of the material. Nearly all of them were detached using the unidirectional debitage technique. A single flake was detached using the bipolar technique (2%). Limited evidence of latent internal fissures was observed as well. Most of the flakes are intact (79%) and these have minimum dimensions of 10x6x1 mm and maximum dimensions of 33x35x13 mm. This results in average measurements of 19x17x4 mm and an average weight of 1.58 g. The length-width index shows an average of 1.2. Most of both the intact flakes and the fragmented ones are partially or fully covered with patina or cortex. Five of them can even be considered decortication flakes (10%). Minor debitage errors have been observed such as oblique detachments or a double bulb or plunging flake.

The blades form a small set of artefacts, all detached using the unidirectional debitage technique. Most of them can be described as 'irregular blades' rather than as long, regular blades with parallel edges and ridges. A few blades are either regular (n: 1), or have sub-parallel edges (n: 3); all others are, sometimes slender, blades, just not as systematically produced. The majority of the blades are still intact (70%), measuring between 12x4x1 mm and 44x22x8 mm. The resulting average is 27x12x5 mm while the average weight is 1.64 g. The fragments are slightly more medial-distal parts (57%) than proximal-medial parts (43%). No medial parts have been observed. The predominant part of the blades, and especially the intact specimens, are still covered with natural surface. Cortex or patina coverage for up to 75% or more, what would result in a definition as decortication blade, is established for two blades (9%). Here also, oblique detachments and a plunging blade were observed.

The rejuvenation pieces are predominantly striking edge rejuvenation pieces, and to a lesser extent production plane rejuvenation pieces. Only one of them is fragmented, the others have minimum and maximum dimensions of 15x8x2 mm and 29x21x10 mm which results in an average of 21x13x6 mm. More than half of them still show some remnants of cortex or patina.

The cores show a wide variety of types, ranging from cores with one striking platform, to cores with two or three platforms, over even cores that are only tested, the type which occurs the most. They are mostly rather small, between 18x12x10 mm and 38x49x34 mm (average 25x26x20 mm) showing often not more than two or three flake scars per striking platform; only two flake – blade combinations occur. One of these is a core with five nicely positioned and rather regular but small blade negatives (23x20x27 mm). The striking platforms are nearly always plain or natural indicating a minimum of core preparation. The presence of rolled or weathered cortex or different kinds of patina on most of the cores indicates their current size is not that different from their original size.

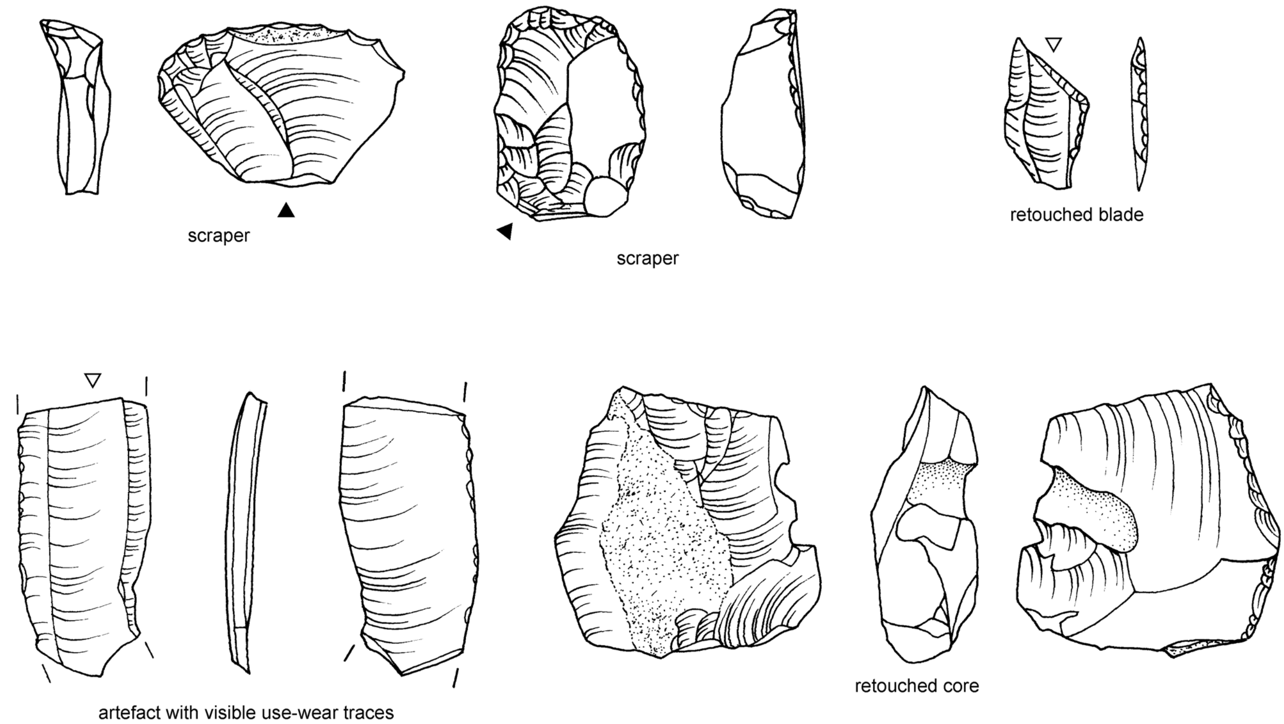

Figure 5.29 Overview of tool types present at sites S80-S84. Scale 1:1.

Tools
This small collection of tools consists of 4 scrapers, 2 microliths, 8 retouched pieces, and 4 smaller or larger indeterminate tool fragments (figure 5.29). All but one were made from fine-grained flint, predominantly the type without bryozoans. The exception is a medium-grained scraper. Three specimens were exposed to heat, all moderately.

The scrapers are defined as one end scraper and three end scrapers with retouched edges. They were produced on a variety of blanks, being two flakes, one blade, and a frost flake, resulting in a variety of shapes. The only aspect in common is the distally located scraper front. These scraper fronts show a wide variety of shapes as well. The scrapers measure between 22x18x4 mm and 31x32x11 mm with an average of 27x22x8 mm.

The microliths are an A-point and a B-point measuring 24x6x2 mm and 13x4x1 mm respectively. They were both produced on blades from fine-grained flint without bryozoans. The B-point is rather atypical and the light damage on the working edge contributes to the hesitant definition.

The retouched pieces are a combination of two retouched flakes, three retouched blades, and three other retouched pieces. The retouched pieces mostly have short, abrupt to semi-abrupt retouches on the dorsal face following the natural curvature of the blank. The retouched pieces are all intact and measure between 12x4x1 mm and 36x37x15 mm. The width of 37 mm is exceptional and the result of the retouched core. The retouched blades in particular are rather small and slender, for example 12x4x1 mm and 13x4x1 mm, whereas two other retouched pieces are retouched quite intensely making them lean towards scrapers.

The remaining tools are two larger tool fragments, both with one retouched edge, and two smaller retouched chips. One of the latter may even be a broken off scraper front.

Remaining flint artefacts
The only artefact with visible use-wear traces is a medial blade fragment of 36x20x3 mm. The blade differs largely from the majority of the blades found at the site as it is a wide and regular blade with two parallel ridges.

The waste material, the second largest group of artefacts at the site, consists of 16 indeterminate fragments, 13 frost flakes, 10 potlids, and 5 nodules. Some minor indications of shattered cores have been found. One of the potlids has a rougher surface than the other artefacts implying it might have been made of a coarser grained flint type or even quartzite. This also applies to one of the nodules. It is not even entirely clear whether the definition of flint is correct or whether it is some sort of quartzite. The patina obscures what possibly may be interpreted as quartz veins. The nodules vary among themselves in measurements; three form a rather tight cluster of minimum and maximum measurements of 27x22x16 mm and 40x35x33 mm, the remaining two measure 73x50x49 mm

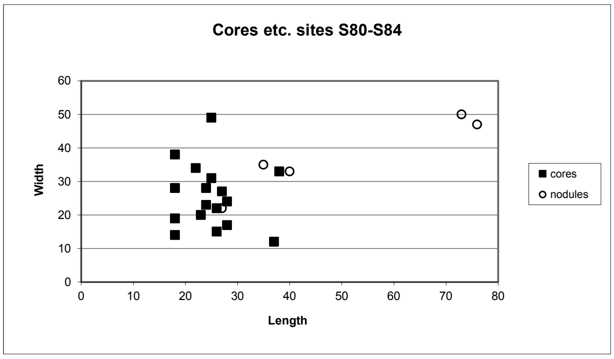

Figure 5.30 Total number of cores and nodules of sites S80-S84.

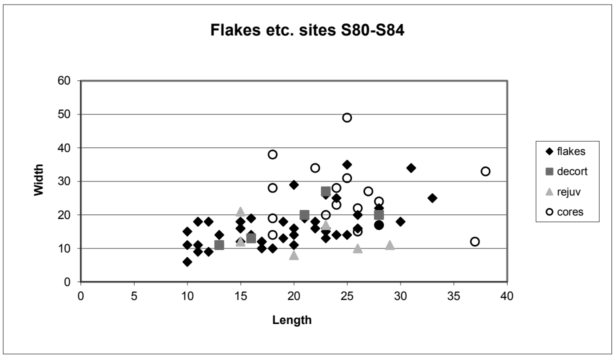

Figure 5.31 Total number of intact flakes, decortication flakes, rejuvenation pieces, and cores of sites S80-S84.

and 76x47x36 mm (average 49x37x32 mm). These two are sufficiently large enough to produce any of the cores (figure 5.30).

The chips make up 26% of the flint artefacts found at this site. They weigh between 0.01 g and 0.77 g with an average of 0.10 g. Observations revealed that microchips mostly weigh between 0.01 g and 0.05 g, meaning that 47% of all chips may be microchips. The weight class of 0.03 g is the most numerous; the heavier weight classes generally show a diminishing amount of artefacts per class. More than half of the chips were damaged by fire (60%). Moderate heat exposure occurs most often, while heavy and light exposures occur progressively less. Although flint type is normally not registered for chips, it was observed that one, presumably, medium-grained flint chip occurs, although it closely resembles very fine-grained quartzite.

Conclusion
The collection of artefacts recovered at these different sites gives some idea of the character of the habitation on this extended river dune. As with several of these limited sets of flint artefacts, this interpretation is rather indicative than representative.

The assemblage is predominantly made up of fine-grained flint. The use of medium- and coarse-grained flint is extremely rare. The mutual percentages of fine-grained flint with and without bryozoans are practically the same for all artefact groups being c. 16% versus 70%, even for the waste material. Although this analysis deals with small differences in percentages within a limited set of artefacts, this might imply that no special attention was paid to the selection of specific raw material types for tools.

The number of artefacts damaged by fire is limited. This is also clearly true for the waste material of which the percentage lowers to 18% when the potlids are excluded. In this way all artefact groups are very similar.

In the artefact groups the debitage material is most numerous, the waste material takes second place, and the tools occur the least. The debitage material itself is dominated by flakes (26%). The ratio between blades and flakes is 1:2.6 as the blades form 10%. Both flakes and blades are mainly intact; of the broken blades the medial-distal parts occur most. The rejuvenation pieces, but especially the cores, are well represented. The size of the flakes falls within the dimensional limits set by the cores, implying they may have been produced at the site (figure 5.31). A few blades and the artefact with use-wear traces fall just outside the dimensional limits of the cores (figure 5.32). The artefact with use-wear traces was probably not produced at the site since it is a regular blade, a debitage technique not observed on the cores at the site. Even more, it is very similar to the blades with use-wear traces found on the levee sites. The other large blades may have been produced at the site, large parts of which were not excavated, as large nodules are present.

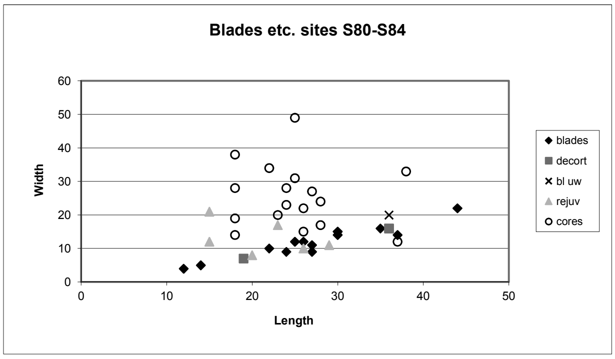

Figure 5.32 Total number of intact blades, decortication blades, rejuvenation pieces, and cores of sites S80-S84.

The cores are characterised by a wide variety of types showing often not more than two or three flake scars per striking platform. Blade production is demonstrated, although rather limited. Core preparation is kept to a minimum, possibly to optimise the use of the rather small nodules.

The toolkit is dominated by scrapers and to a lesser extent different kinds of retouched pieces. These were all produced on a wide variety of blanks. Two of the

retouched blades are small and slender possibly pointing to a Mesolithic date. The microliths also give evidence of Mesolithic habitation whereas the regular blade with visible use-wear traces is of Neolithic date. As all other tools fall within the dimensional range set by the flakes, blades, and cores, there is no way of knowing whether they are of Mesolithic or Neolithic date.
More striking is the near absence of the bipolar technique. One flake is interpreted as a bipolar flake, yet no typical bipolar pieces, as seen so often on the levee sites, was observed on any of these river dune sites.

The low percentage of heat damage observed with the larger artefacts is also the case for the artefacts < 1 cm. The dominance of moderate heat exposure, over heavy and light exposure is observable in both artefact groups.

5.3 Raw material types and procurement

5.3.1 Introduction

As no flint, or any other stone material for that matter, naturally occurs in the soils around Swifterbant, all the flint needed to be transported to the site. At the procurement sites, a selection of raw material types and nodule shapes must have taken place as some were preferred to others. Possibly even different procurement sites were chosen for their specific types or quality of available flint. The identification of such sites is not always as easy as it would seem because the variety of flint types present at the Swifterbant sites do not have to represent one specific procurement site.

Additionally, certain types of flint are clearly discernible as northern or southern types. Yet, some varieties of flint cannot be designated to a specific source at all; they lack any significant characteristics.

5.3.2 Northern versus southern flint

All the sites combined resulted in the recovery of c. 52,110 flint artefacts. Of these 21,965 were analysed by raw material type (42%). The predominant use of fine-grained flint with or without bryozoans is discernible on all sites and for all artefact categories (tables 5.9 and 5.10). The supremacy of fine-grained flint without bryozoans over fine-grained flint with bryozoans is also maintained on all sites but not in all artefact categories. The application of medium- and coarse-grained flint is for all sites different, yet in all cases the percentages never exceed 2.5%. Furthermore, medium-grained flint types occur more often than coarse-grained flint types. Even if the percentages per flint type differ for each site individually, the material is all very similar, with comparable cortex and patina types regardless of the coarseness of the flint, and presumably it all originates from the same procurement sites.

More specifically, the colours of the two fine-grained flint types range from pale beige over different tones of grey to almost black. Within this range two main colours can be distinguished: brown shades and grey shades. The first vary from beige over orangey to chestnut brown, the second from light mouse-grey over brownish- or bluish-grey to darker grey and almost black. The brownish colours are above all translucent, the greyish colours can both be translucent or opaque, sometimes even mottled or 'cloudy'. The amount of bryozoans is variable; sometimes a few small fossils are visible, at other times large quantities of visually good definable bryozoans occur. Other inclusions and fossils have been noticed as well.

Quite a few artefacts are still partially or fully covered with a natural surface. The remnants of these natural surfaces may be made up of cortex and/or patina. The cortex is mostly weathered or rolled. Only a few artefacts with fresh, chalky cortex or with heavily battered, pseudo-cortex[13] occur. The diverse types of patina are more evenly dispersed as various colours, gloss or windblown patina occur in different combinations. The anterior colour patinas range from white or brown to dark grey or even black, and may be combined with different kinds of anterior gloss, such as windblown patina or a softer sheen or gloss. Polish, as in polished flint axes, is grouped with the patinas, yet as it is man-made it is described separately. Furthermore, special attention to raw material type and colour may give information on the possible number of polished flint axes present on the sites. More than a few artefacts are covered with posterior gloss while posterior colour changes occur only sporadically. Finally, several of the burnt artefacts have a weathered and granular surface, with or without sparkles or may present a mirror-like shine. They are both definitely a reaction of the raw material to heat exposure but the nature of the raw material is unclear. As the surface of the artefacts with a weathered and granular surface is rough, a medium- or coarse- grained material is expected. This may be flint but it cannot be ruled out that it might point to the presence of burnt quartzite artefacts.

Within this vast amount of flint artefacts, not one artefact was produced out of southern flint. The only possible exceptions are the polished flint axes and fragments thereof. These have been encountered at sites S3, S4, and trenches S21-S24, and are typologically linked to the Michelsberg culture. This gives them a 'southern' designation. Yet, none of them could positively be defined as a specific type of southern flint like for example Valkenburg

13 This pseudo-cortex differs from the Miocene rolled and battered cortex as seen on Meuse eggs (*Maaseitjes*). They have in common that the surface is interspersed with countless circular fissures as the result of Hertzian cones. Yet, the typical bluish patina is missing with the pseudo-cortex.

Table 5.9 Percentages of different flint types at the levee sites at Swifterbant.

S2	Number	FG B	FG	MG (B)	CG (B)	Indet.
Debitage material	505	15.6%	47.7%	3.0%	0.4%	33.3%
Tools	198	19.7%	56.1%	3.5%		20.7%
Bipolar pieces	26	11.5%	84.6%			3.8%
Visible use-wear	65	30.8%	50.8%	3.1%		15.4%
Waste	233	6.4%	41.2%	0.9%	0.4%	51.1%
Total	**1027**	**156**	**503**	**26**	**3**	**339**
	100%	15.2%	49.0%	2.5%	0.3%	33.0%

S3	Number	FG B	FG	MG (B)	CG (B)	Indet.
Debitage material	11147	17.6%	64.9%	1.3%	0.3%	15.9%
Tools	1420	21.8%	62.4%	1.5%	0.4%	13.9%
Bipolar pieces	721	28.0%	62.4%	0.8%	0.7%	8.0%
Visible use-wear	468	19.4%	70.5%	2.6%	0.2%	7.3%
Other	40	2.5%	62.5%	32.5%		2.5%
Waste	2375	9.2%	48.3%	2.1%	0.5%	39.9%
Total	**16171**	**2785**	**10074**	**249**	**55**	**3008**
	100%	17.2%	62.3%	1.5%	0.3%	18.6%

S4	Number	FG B	FG	MG (B)	CG (B)	Indet.
Debitage material	918	15.0%	61.8%	2.0%	1.1%	20.5%
Tools	163	19.6%	60.7%	3.0%		16.6%
Bipolar pieces	52	13.5%	73.1%			13.5%
Visible use-wear	78	24.4%	64.1%	1.0%		10.3%
Other	3		33.3%			66.7%
Waste	270	6.3%	36.7%	1.0%	0.7%	54.8%
Total	**1484**	**213**	**854**	**25**	**12**	**380**
	100%	14.4%	57.5%	2.0%	0.8%	25.6%

S41	Number	FG B	FG	MG (B)	CG (B)	Indet.
Debitage material	31	25.8%	48.4%			25.8%
Tools	4	25.0%	75.0%			
Bipolar pieces	2		50.0%	50.0%		
Visible use-wear	1	100.0%				
Waste	19	26.3%	63.2%			10.5%
Total	**57**	**15**	**31**	**1**		**10**
	100%	26.3%	54.4%	1.8%		17.5%

S51	Number	FG B	FG	MG (B)	CG (B)	Indet.
Debitage material	83	15.7%	72.3%	1.2%		10.8%
Tools	27	25.9%	51.9%		3.7%	18.5%
Bipolar pieces	3		66.7%			33.3%
Visible use-wear	12	8.3%	75.0%	8.3%		8.3%
Waste	27	14.8%	29.6%		3.7%	51.9%
Total	**152**	**25**	**93**	**2**	**2**	**30**
	100%	16.4%	61.2%	1.3%	1.3%	19.7%

FG: fine-grained flint without bryozoans, FG B: fine-grained flint with bryozoans, MG (B): medium-grained flint with or without bryozoans, CG (B): coarse-grained flint with or without bryozoans, Indet.: indeterminate type of flint.

Table 5.10 Percentages of different flint types at the river dune sites at Swifterbant.

S21-S24	Number	FG B	FG	MG (B)	CG (B)	Indet.
Debitage material	1929	27.0%	49.5%	0.5%	0.4%	22.6%
Tools	93	29.0%	58.1%	2.2%		10.8%
Bipolar pieces	3	100.0%				
Visible use-wear	6	33.3%	66.7%			
Other	2		50.0%		50.0%	
Waste	52	18.9%	35.8%			45.3%
Total	**2085**	**563**	**1032**	**12**	**8**	**470**
	100%	27.0%	49.5%	0.6%	0.4%	22.5%

S61	Number	FG B	FG	MG (B)	CG (B)	Indet.
Debitage material	621	15.8%	78.3%	0.5%		5.5%
Tools	20	5.0%	70.0%		5.0%	20.0%
Bipolar pieces	1		100.0%			
Visible use-wear	4	25.0%	50.0%	25.0%		
Waste	148	25.0%	60.1%	0.7%		14.2%
Total	**794**	**137**	**592**	**5**	**1**	**59**
	100%	17.3%	74.6%	0.6%	0.1%	7.4%

S80-S82	Number	FG B	FG	MG (B)	CG (B)	Indet.
Debitage material	108	15.7%	71.3%	1.9%		11.1%
Tools	18	16.7%	66.7%	5.6%		11.1%
Visible use-wear	1	100.0%				
Waste	44	15.9%	70.5%			13.6%
Total	**171**	**28**	**120**	**3**		**20**
	100%	16.4%	70.2%	1.8%		11.7%

FG: fine-grained flint without bryozoans, FG B: fine-grained flint with bryozoans, MG (B): medium-grained flint with or without bryozoans, CG (B): coarse-grained flint with or without bryozoans, Indet.: indeterminate type of flint.

or Rijckholt flint. Even more, fragmentation rate is so high the original shape of the axes could not be determined. Additionally, the bi-coloured flake from site S2 was more likely made out of Scandinavian flint than southern, i.e. Lousberg flint.

The artefact produced out of Rijckholt flint, or the Meuse egg, mentioned by Raemaekers (1999: 37, table 3.10) could not be recognised within the surviving objects. It was however observed that some artefacts have a certain southern feel about them based on colour composition, texture, and inclusions, yet none could positively be defined as a specific type of southern flint.

Thus, a fair amount of flint artefacts are clearly of northern origin (bryozoans), while no specific southern flint types have been recognised. Yet, this does not mean that all material is by definition of northern origin. Some flint types show no characteristics linking them to specific procurement sites; they could be either northern or southern.

5.3.3 Procurement sites

The fact that a number of the removals and indeterminate fragments are detached along latent internal fissures such as Hertzian cones and frost fissures, combined with the presence of rolled or even pseudo-cortex, frost flake scars, and windblown patina, indicates that the flint nodules were transported and have been exposed to environmental influences for a long time. Combined with the generally small dimensions of the cores and nodules, this implies the secondary deposition of the raw material.

With the possible exception of the polished flint axes (see above), none of the flint material at Swifterbant can positively be defined as southern flint. Thus the gathering of raw material for flint tool production at Swifterbant mainly, or possibly even solely, occurred at procurement sites with northern flint. The general appearance and the texture of the cortex and patina suggest that this gathering occurred at secondary procurement sites. The most likely sources of such types of flint are the boulder clay outcrops at Urk and Schokland as these are the closest to the Swifterbant sites. Other boulder clay outcrops in the area may of course have been good procurement sites as well.

As said, certain varieties of flint cannot be retraced to specific outcrops. It is therefore not unlikely that other procurement areas than boulder clay outcrops within the Swifterbant territory were exploited as well.

5.3.4 Comparison of the preferred flint types

The predominant use of fine-grained flint is well attested on all sites and in all artefact categories. This also applies to the dominance of medium-grained flint over coarse-grained flint. The individual percentages, however, show small fluctuations per site. Above two tables were produced to compare the levee sites with the river dune sites (see tables 5.9 and 5.10). Radiocarbon dates have shown different occupation phases for the two geomorphological units and this might be reflected in the flint type selection. The next few sections are divided by site type, while the comparison will be made first by the total number of artefacts, then by the different artefact categories. The different artefact types will be discussed at the end. It should also be mentioned that the inability to define artefacts by flint type was always the result of heavy heat exposure, i.e. overheating.

For the levee sites, site S3 shows the highest percentage of fine-grained flint (79.5%), site S2 the lowest (64.1%). Site S2, however, has, along with site S4, the highest percentage of medium- and coarse-grained flint artefacts while site S3 shows the lowest (1.9%). This image is enhanced when we consider that a part of the medium-grained artefacts on site S3 are polished axe fragments while on site S2 none were found. Sites S2 and S4 also represent the extremes when heat exposure is concerned, again site S3 is the lowest. Site S51 is in the middle, leaning towards S2 and S4 when medium- and coarse-grained flint types are involved, leaning towards S3 when heat exposure is involved.

As the debitage material forms the largest proportion of the artefacts ≥ 1 cm, their influence on the general distribution of raw material types is significant. At all levee sites, they form the largest percentage of the total amount of artefacts. The tools are more often made out of fine-grained flint compared to the total number of the assemblage but also compared to the debitage material, i.e. tool blanks. However, this slight dominance is the result of fewer heat exposed specimens as the medium- and coarse-grained flint amounts stay the same. Thus, there appears to be no special selection of raw material types for the tools. When the heat-damaged artefacts are taken out of the equation this becomes apparent. Only at site S51 are the percentages between the two fine-grained flint types different. It can however not be ruled out that the small amount of artefacts has influenced these results. The same goes for the medium- and coarse-grained flint both represented by two artefacts. At all sites, the tools are thus less often burnt compared to the total number of artefacts. This counts for most artefact categories as the high level of heat exposed artefacts is because of the waste group. These two features, the dominance of fine-grained flint and the low number of burnt specimens, are not only attestable for the tools but also hold for the artefacts with visible use-wear traces. As said, this is different for the waste material. Here, fine-grained flint types occur less often than in the overall picture while burnt specimens occur more often. It is, however, not only the result of the potlids within this category of artefacts. When these are taken out of the equation, their number remains high with 57% for site S2, 39% for site S3, 58% for site S4, and 46% for site S51. Even more, when the heat-damaged artefacts are excluded the amount of fine-grained flint is more and the amount of fine-grained flint with bryozoans is less than that of the debitage material and the tools.

The low number of artefacts at site S41 makes a comparison indicative rather than representative. Roughly the same picture as on the other four levee sites emerges, with the same materials and artefact types. However, the number of fine-grained flint with bryozoans is somewhat elevated because of the debitage material. This artefact category also has a higher percentage of burnt specimens.

For the river dune sites the picture is mostly similar. The dominance of fine-grained flint, and of medium- over coarse-grained flint, is attested. However, the percentages of medium- and coarse-grained flint are lower than on the levee sites. The 1.8% of sites S80-S84 is related to the overall low number of artefacts. Had only two medium-grained artefacts been found, instead of three, the percentage would have been lower at 1.2%. Additionally, on sites S61 and S80-S84 the number of burnt artefacts is also much lower than on the levee sites which results in the higher percentages of fine-grained flint, especially at site S61. The highest percentages of fine-grained flint without bryozoans can also be found on this site, as well as at sites S80-S84. In contrast, trenches S21-S24 have the highest amount of heat-damaged artefacts and of fine-grained flint with bryozoans. This is all at the disadvantage of fine-grained flint without bryozoans.

Again, the debitage material highly influences the general distribution of the raw material types by its numerical supremacy. For the tools the dominance of fine-grained flint compared to the general distribution is no longer observed on sites S61 and S80-S84, this appears to be taken over by the debitage material. Trenches S21-S24 still show the same picture as the levee sites. The low number of bipolar pieces and artefacts with visible use-wear traces make a comparison for these artefact types impossible. The high number of burnt artefacts with the waste material is observed, a feature clearly seen at trenches S21-S24.

This site clearly differs on more aspects from the other two river dune sites.

In closer detail, on the artefact level, the comparison becomes more complicated and less straight forward. Percentages fluctuate per site and artefact type blurring a clear-cut image. Some general observations can be made.

Within the set of debitage material of the levee sites the cores are exposed to heat least often (9%), for the flakes and blades this is c. 18% and for the rejuvenation pieces 14%. The percentages of medium- and coarse-grained flint are evenly dispersed between the four artefact types (c. 2%), as are the fine-grained flint without bryozoans (c. 65%). Only the fine-grained flint with bryozoans is slightly elevated for the cores and rejuvenation pieces (22%) compared with the flakes and blades (c. 17%). In addition, nodules are exposed to heat even less than cores (8%) and only two medium-grained specimens occur (1.5%), while fine-grained flint without bryozoans was clearly preferred to fine-grained flint with bryozoans (c. 70% and 21% respectively). Thus, medium- and coarse-grained flints were knapped at the sites, especially at sites S2, S3, and S4, just as the fine-grained flint types. When percentages of natural surface are cross referenced with the different flint types only small differences arise. Coarse-grained flint artefacts are more often covered for 100%, because of several decortication flakes and blades, and medium-grained flint artefacts are more often without any cortex or patina. It must be mentioned that as the amount of medium- and coarse-grained flint types are limited, light fluctuations are easily influenced by two or three artefacts. For the river dune sites their number is less than thirty making a comparison insignificant.

When the tool types are regarded separately very few seem to deviate from the general picture given in tables 5.9 and 5.10. The ratio 60% - 20% for the fine-grained flint without bryozoans and fine-grained flint with bryozoans is maintained at sites S2, S3, and S4. For sites S41 and S51 the individual tool types are represented by too few specimens to be of any use to the comparison. The two artefact types varying from this are the indeterminate tool fragments and the polished axe fragments. The expected reason for this deviation is the heavy heat exposure for the indeterminate tool fragments and the pronounced preference for medium-grained flint for the polished axe fragments.

For the river dune sites the low heat exposure of the cores is attested as well (9%) compared to 19% for all three other artefact types. For the distribution of the different flint types the equation becomes more complicated. Essentially, for the debitage material sites S61 and S80-S84 are very alike, showing c. 80% of fine-grained flint without bryozoans and c. 20% of fine-grained flint with bryozoans for the cores and the rejuvenation pieces, and a total absence of medium- or coarse-grained flints. For the flakes and the blades these percentages are 80 % and 15% for the fine-grained flint without bryozoans and fine-grained flint with bryozoans, and 1% for the medium- and coarse-grained flint types. The remaining 4% is exposed to heat. Trenches S21-S24 are very similar to the levee sites, even the lightly elevated percentage for fine-grained flint with bryozoans for the cores and rejuvenation pieces. One small detail, no medium- or coarse-grained cores or rejuvenation pieces are observed either. Even more, no medium- or coarse-grained nodules have been found on the river dune sites. These are exclusively from fine-grained flint, 86% of the type without bryozoans, 14% of the type with bryozoans.

The individual tool types are often too low to be usefully compared. The microliths are sufficient in number and are predominantly produced out of fine-grained flint without bryozoans (85%). This is the clearest evidence of the selective use of a certain flint type for any of the artefact types, including the tools. The scrapers and the retouched pieces give mixed signals. fine-grained flint without bryozoans is preferred for the scrapers and the retouched blades, while fine-grained flint with bryozoans is preferred for the retouched flakes. It should be mentioned that, although the percentages of medium- and coarse-grained flint for the tools in table 5.10 are generally high, in absolute numbers these two types of flint are most commonly used for the tools on the levee sites.

When the two types of sites are compared to each other, it appears that the river dune sites are characterised by a very high number of fine-grained flint types, reaching up to 86.5% and 91.8%. The number of medium- and coarse-grained flint types is limited to 0.8% - 1.8%, which is equal or less than the percentages on the levee sites, and the result of absences in cores, rejuvenation pieces and limited amounts of tools in these two flint types. It may therefore be questioned if medium- and coarse-grained flints were knapped at the river dune sites in the first place. They obviously were at the levee sites, as small amounts of them were found throughout the debitage material at sites S2, S3, and S4. The only medium-grained nodules were also found at site S3. It appears that the lower number of fine-grained flint on the levee sites is thus mainly the result of the higher number of burnt artefacts as the medium- and coarse-grained flint types take up only a very small portion of all artefacts. This is especially so on site S2. The highest score of medium-grained flint is also found at this site, contributing as well to the lower number of fine-grained flint artefacts.

Thus, the preference of fine-grained flint is especially visible on the river dune sites, especially for the type without bryozoans; in other words, the near absence of medium- and coarse grained flint. Trenches S21-S24 form the exception with a percentage of burnt artefacts rallying the levee sites S2 and S4. Also on the distribution of fine-grained flint without bryozoans versus fine-grained flint with bryozoans the site leans more towards the levee sites than to the river dune sites. One of the possible explanations would be that the admixture of Neolithic material is more pronounced in trenches S21-S24 than on sites S61 and S80-S84. Some of the artefact types have already suggested this. As a final remark, S2, S4 and S21-S24 have the presence of a Neolithic cemetery in common. Whether the presence of this cemetery is related to the large amounts of heat exposed artefacts can only be suggested.

5.3.5 Interpretation and conclusion

The composition of the raw material reveals that mostly, and possibly exclusively, northern or local flint was collected from the boulder clay outcrops near Swifterbant. The only possible exceptions are the polished flint axes. Culturally linked to the Michelsberg culture, these tools have a southern affiliation. They also point to a Neolithic occupation phase at the sites where they are found (sites S3, S4, and trench S23). Their limited number, very fragmentary state, and small dimensions indicate the rareness of these items. It appears that the artefacts were brought to the site as smaller fragments, like flakes and smaller debitage material. Thus, polished flint axes cannot be considered as a complementary source of flint as suggested by Deckers (1982: 35); they must be interpreted as rare import items.

Even though the pieces belong to a limited number of axes, the fragments themselves are not large or numerous enough to form even one complete axe. Also few refits have been found. Therefore, it may be that the artefacts were brought to the site as smaller fragments, i.e. 'imported' as flakes and smaller debitage material. Axes were thus presumably not brought to the site as a supply of raw material (contra Deckers 1982: 35). As only two chips occur, it is not even likely the axes were shattered or reworked into debitage material at the sites themselves and then largely transported away.

Boulder clay outcrops can be found at Urk and Schokland, some 10 to 14 km from the sites at Swifterbant. This is presumably not the only source where northern flint was gathered. Within the Noordoostpolder and the neighbouring areas more boulder clay outcrops are present. These were all accessible within a one day's travel (site territory or foraging zone). Easy access by river systems may have been preferred. Other procurement sites of flint located within the year territory of the Swifterbant people are the Veluwe or the Utrechtse Heuvelrug, some 30 to 40 km from the sites. More sources may be used as well, especially for the undiagnostic flint varieties. The polished flint axes point to a sphere of influence of at least 150 km to the south.

The assemblage reveals a clear preference of fine grained flint, mostly without bryozoans. The percentages of medium- and coarse-grained flint remain very low at all sites. Most heat exposed artefacts occur on sites with cemeteries: sites S2, S4 and trenches S21-S24. Whether there is a connection between the two aspects is open to debate. As said, the dominance of fine-grained flint is observed at all sites, yet a near absence of medium- and coarse-grained flint is attested at the river dune sites, with especially rejuvenation pieces and cores being absent. Thus all medium- and coarse-grained artefacts may have been produced at the levee sites where the whole operational chain is observed. This implies that the medium- and coarse-grained flint artefacts could all be of Neolithic origin.

Tools and artefacts with visible use-wear traces are less often burnt than the overall amount of artefacts as well as the debitage material. However, the dominance of fine-grained flint with these tools compared to debitage material is only the result of this limited heat exposure as the percentages of medium- and coarse-grained flint types remain the same. Thus no special selection of certain flint types occurred for the tools. For the bipolar pieces, nearly exclusively present on the levee sites, this is however true, the dominance of fine-grained flint without bryozoans is present on all levee sites except on site S3.

The waste material always shows larger amounts of heat exposed material which is not only the result of the potlids. When these heat exposed artefacts are taken out of the equation it becomes apparent that the percentages of fine-grained flint without bryozoans for this artefact category are also higher than for the debitage material or the tools.

It is clearly attested that trenches S21-S24, in more than one aspect, are similar to the levees, and largely different from sites S61 and S80-S84. This implies the admixture of Neolithic flint material, already indicated by several artefacts types, is more pronounced than on the other two river dune sites.

5.4 Use-wear analysis

5.4.1 Introduction

The use-wear analyses performed on the flint artefacts of the Swifterbant cluster sites were conducted in two stages. First Bienenfeld (1985) analysed flints from sites S2, S4, and S51 in a preliminary way to answer questions on subsistence strategy and settlement pattern; some activities performed at the site revealed themselves and a provisional function of the three sites was given.

For the present study, new use-wear analysis was necessary as new artefact types and questions arose. This analysis was conducted on material from sites S2, S3, S4, S51, and S61 by the Laboratory of Artefact Studies (Leiden University) and specialists from the Groningen Institute of Archaeology (University of Groningen). It was observed by all researchers that the material was well

Table 5.11 Number of analysed artefacts per site and the amount of traces observed.

	S2	%	S4	%	S51	%
Traces	68	54%	40	50%	51	23%
No traces	35	28%	34	43%	137	61%
Indeterminate traces	24	19%	6	8%	35	16%
Analysed	**127**		**80**		**223**	

preserved. This 'fresh appearance' of the traces makes the material highly suitable for use-wear analysis.

In the next section the different analyses will be presented one by one. Interpretations of a functional kind will be discussed here as well as in section 5.7.2.

5.4.2 *The old use-wear analysis*

After a section on the technical aspects of the method applied, the results of the use-wear analysis are discussed by Bienenfeld (1985) per site; this division is maintained in this research (table 5.11). It should be mentioned that the number given in the tables below are copied from Bienenfeld (1985) and represent the number of used areas, thus not of the examined artefacts. However, this is of no relevance for sites S2 and S4 where all examined artefacts have one area showing traces; only on site S51 did an artefact bear traces of double use resulting in 52 used areas on 51 artefacts.

In the late seventies, the time frame in which the research was done, the method of use-wear analysis was still in its early years and developing continuously. This should be taken into account when the validity of the upcoming research is considered.

Of the flint assemblage of site S2, out of 1503 artefacts available at that time, a sample of 127 artefacts (8%) was selected, consisting of retouched tools, blades, and blade fragments. Of these artefacts 68 showed traces of usage (54%) (table 5.12) while 35 artefacts showed no use-traces at all; in 24 cases the presence of traces could not be determined. The contact materials were predominantly soft plants (31%) and hide (25%); a few (6%) had been used on bone or antler and wood. On a rather large percentage (32%) traces were recognised but the type of contact material could not be defined. It was observed that the plant polish also contained scratches indicating both cutting and scraping motions.

The flint assemblage of site S4 consisted at that time of 245 artefacts[14]. Bienenfeld (1985) selected all blades, blade fragments, and retouched tools, a total of 80 artefacts (33%). Of these 40 specimens showed traces of use (50%) (table 5.13), 34 were not used at all, and on 6 specimens

Table 5.12 Wear frequencies of flint artefacts at site S2.

	S2	%
Soft plant	21	31%
Hide	17	25%
Bone or antler	4	6%
Wood	4	6%
Indeterminate use	22	32%
Total	**68**	

Table 5.13 Wear frequencies of flint artefacts at site S4.

	S4	%
Soft plant	12	30%
Hide	12	30%
Bone or antler	4	10%
Wood	1	3%
Indeterminate use	11	28%
Total	**40**	

Table 5.14 Wear frequencies of flint artefacts at site S51.

	S51	%
Soft plant	12	23%
Hide	10	19%
Bone or antler	1	2%
Wood	3	6%
Indeterminate use	26	50%
Total	**52**	

the presence of traces could not be established due to heat exposure or the presence of patina. Both soft plant and hide processing occur the most (30%), followed by bone or antler processing and one example of wood working. The soft plant polish, often the result of contact with wheat or reeds, mainly occurring on the blades, is well developed, and indicates cutting and other plant processing activities. In this regard Bienenfeld (ibid: 202-203) refers to ethnographic studies suggesting that these activities may include basketry and the production of matting and winnowing receptacles.

14 However, Deckers mentions only 244 artefacts (Deckers 1979: 161) whereas the number of artefacts still present today is 242.

All of the 223 artefacts available at that time for site S51 were examined (100%). A total of 51 specimens showed traces of use (23%) (table 5.14), 137 were not used at all, and 35 were covered with patina or exposed to heat preventing an analysis. One of the used artefacts has a double function raising the number of used areas to 52. The unused artefacts mainly are flakes and cores. The observed traces are mainly soft plant (23%) and hide (19%), and to a much lesser extent wood and bone or antler. The number of artefacts of which the contact material could not be defined is rather high (50%) compared to sites S2 (32%) and S4 (28%).

The amount of selected and analysed material on the three sites is rather different, both in exact numbers and in percentages per assemblage. Yet, this revealed no differences between the three sites as to the variety of activities. The only difference is the percentages in which these activities are represented per site and still these do not vary much. The predominance of soft plant and hide processing traces over bone or antler and wood traces can be established at all sites. Soft plant processing occurs slightly more than hide processing whereas bone or antler and wood working are mutually divergent per site. More remarkable is the percentage of used artefacts compared to unused artefacts. For sites S2 and S4 this is roughly 50% but on site S51 this is merely 23%. Combined with the high number of undefined contact materials it appears that site S51 is somewhat different from sites S2 and S4. This is surely the result of the composition of the samples that contain only blades and tools on sites S2 and S4 and consist of all types of artefacts on site S51. Whether the high number of undefined contact materials for site S51 also points to some other sort of discrepancy is unclear.

On all three sites a variety of daily activities was carried out. Bienenfeld (1985: 205) translates the existing traces to a range of activities such as harvesting / gathering and processing of grassy plants, animal butchering, various stages of hide preparation, and wood working. One of the most remarkable absences is that of processing fish. Scaling and gutting fish results in a distinctive polish (ibid: 205) and is therefore presumably not overlooked. Bienenfeld (ibid: 205) further writes that “the occupants used the site repeatedly for the kinds of activities that make up a continuous occupation.”

5.4.3 The new use-wear analyses

A small number of the flint artefacts were recently examined for the presence of use-wear traces. First a pilot study was conducted on 14 blades from the new excavation on S4. As this analysis proved to be fruitful, another 138 pieces from different sites were analysed in a later stage. These studies were all conducted by Annelou van Gijn together with her team, consisting of Channah Nieuwenhuis, Annemieke Verbaas, and Karsten Wentink, from the Laboratory of Artefact Studies (Leiden University). Additional analyses were performed by Inger Woltinge and Dick Stapert from the Groningen Institute of Archaeology (University of Groningen). Finally, an additional handful of bipolar flakes were examined by Inger Woltinge.

Table 5.15 Number of analysed tools and types of observed traces.

Pilot study	S4	Scraping	Cutting	Hafting
Analysed	14			
Traces	12			
No traces	2			
Types of traces				
Siliceous plant	10	6	2	3 ?
Hide				
Bone or antler				
Wood	1		1	1 ?
Indeterminate use	1			
Total	**12**	**6**	**3**	**4 ?**

Table 5.16 Number of analysed artefacts per site.

Second study	S2	S3	S4	S51	S61
Bipolar pieces		28			
Rounded pieces	2	7	1		
Blades use-wear	23	55	10	4	1
Blades		7			
Total	**25**	**98**	**11**	**4**	**1**

Almost all blades analysed during the pilot study appear to have been used (table 5.15). On two blades no traces could be found while one blade was so heavily altered by postdepositional processes that the existing traces could not be interpreted. This results in eleven blades with analysable use-wear traces. Ten of these were employed to process siliceous plant material. In most cases the siliceous plant material could not be further specified by species, yet for two artefacts it may have been reed. These ten blades were mostly handled in a scraping manner leaving small transverse scratches in the polish. The cutting of siliceous plant material was only observed twice; in both cases the band of polish was too thinly spread on the edge of the artefact for them to be interpreted as sickles. The eleventh blade was probably used to cut soft wood. Additional traces were observed on six pieces. Traces that may be interpreted as the result of hafting appear on four blades, postdepositional processes left traces on the two other blades.

The second analysis proved to be more complicated. Two sets of the material were analysed by the Laboratory of

Table 5.17 Types of observed traces on the blades with visible use-wear traces divided per site. The numbers given in the table represent the number of used areas, not the number of the examined artefacts.

	S2	Scraping	Cutting	Hafting
Siliceous plant	16	9	8	1
Hide	1			1 ?
Antler	1			1 ?
Indeterminate use	4		1	
No traces	2			
	S3			
Siliceous plant	44	41	6	
Plant undefinable	1		1	
No traces	10			
	S4			
Siliceous plant	5	5		
No traces	5			
	S51			
Siliceous plant	4	4	1	
	S61			
No traces	1			

Artefact Studies (table 5.16), comprising two groups: bipolar and rounded pieces; and blades, some with visible use-wear traces, and a handful of blades without macroscopically visible traces. On my request, several of the artefacts from the first group, i.e. the rounded pieces, were also analysed by two specialists of the Groningen Institute of Archaeology. This, however, did not lead to an outcome, which was hoped for, but to an impasse. The gist of it all is that the first team interprets the rounding as a hafting arrangement while the second team interprets it as the result of the usage as strike-a-lights (see Devriendt 2008b, Woltinge et al. 2008, van Gijn 2008a).

The first set of artefacts was analysed with a specific question in mind, to find out whether sickles could be identified within the large amount of blades with visible use-wear traces. A secondary question was whether a variation within the plant processing activities could be established. Therefore, only the parts of the edges showing clear traces of polish were analysed (van Gijn et al. 2007). Most blades with visible use-wear traces have traces of contact with siliceous plant material (table 5.17). A total of 18 specimens could not be analysed, often due to heat exposure, whereas others showed no polish at all; they only appeared to have use-retouch.

Most of the tools were used in a scraping motion, whereas a minority was used for cutting. On a few blades both motions could be detected, often on separate edges and rarely together. It was also observed that the traces on the 'working edge' were more developed than on the opposing 'non-contact surface'. On site S2 a blade with traces of hide and antler working was also discerned; the artefact seemed to have been hafted. Scraping and cutting motions are roughly equal on this site, whereas on all other sites the scraping motion is nearly always exclusively present. Even more, these sites show only evidence of contact with siliceous plant material.

The handful of blades also mainly showed traces of siliceous plant material, both in scraping and cutting motions. Traces of hide and a mineral substance could be detected on another blade, possibly in combination with bone or antler, and this in a scraping motion. Two blades were too heavily exposed to heat to detect any traces.

Thus, based on the analysis of blades with visible use-wear traces it appears that a larger variety of activities was performed at site S2 compared to sites S4, S51, and S61; the artefacts at site S3 also revealed more than one contact material. However, the presence of sickles could not be detected. The typical polish seen on artefacts used in experimental harvesting studies of domesticated grains was not observed. The processing of siliceous plant material on the other hand was clearly attested. To what extent the transversal oriented polish is related to the processing of plant material for the production of baskets or fibres, or to food processing and food supply, is the topic of ongoing experiments. One of the options is that the blades are used in a transverse to oblique manner to pluck, or scrape, the ears from the stems (van Gijn et al. 2007).

The second set of artefacts was analysed with a different question in mind, a question of functionality and activity type. For the bipolar pieces, I was interested to know whether use-wear traces could reveal anything on the function of the artefacts, more specifically the three different morphological types observed, i.e. the regular pieces, the square shaped pieces, and the irregular pieces. The main question for the rounded pieces was the activity that would have caused the heavy wear on the artefacts.

The bipolar pieces showed practically no traces. Only on 2 of the 28 artefacts were traces observed suggesting the 'apparent disuse' of the numerous bipolar pieces; this means that there is no evidence they were used, though this does not mean that they were not. One of the square shaped pieces revealed a little area of plant polish on one of its edges. The other, a regular bipolar piece, showed traces on one of the tips or corners of the striking edge. Traces of engraving a hard contact material were observed, presumably of bone. These traces do not correspond with the presumed function of the bipolar pieces, for example that of wedge or core (see section 3.2.4). Instead, they reveal an opportunistic use of artefacts at hand. In this respect the explanation by MacDonald (1968) that they were burins indeed proved to be true for one artefact. It cannot however be ruled out that the bipolar pieces were used as wedges or cores but that these activities simply did not leave any traces on the pieces themselves. It is not hard to imagine that a use as wedge results in the detachment of

Table 5.18 Types of observed traces on the rounded pieces.

Rounded pieces	S3	Scraping	Cutting	Piecing	Engraving
Siliceous plant	3	2	1		
Hide	2	1		1	
Wood	2	1	1		
Indeterminate use					
No traces	2				
Bipolar pieces					
Plant undefinable	1	1			
Bone	1				1
No traces	26				

very small pieces of the working edge, well before traces are able to develop.

The analysis of the traces on the rounded pieces was less straight forward (table 5.18). The interpretations were very diverse ranging from no traces at all, to traces of hide, or mineral substances and natural wear[15]. Even when all four researchers re-examined the pieces together, interpretations varied widely. It seems that this phenomenon will not let itself be explained that easily.

Recently, I argued (Devriendt 2008b) that several activities may result in the rounding-off of artefacts. As a layman in the field of use-wear analysis it is hard to decide which interpretation is more likely to be valid. Therefore, some possible activities that can lead to rounding are listed here. First of all, a difference should be made between microscopically and macroscopically visual rounding. Scrapers, backed blades, and arrowheads sometimes show minimal rounding of the working edges. This may be the result of scraping or cutting of hide. For the arrowheads, the abrading of tangs on a soft stone is considered to be related to hafting. These are only minor changes, hardly visible to the naked eye. Archaeological experiments established that the addition of ochre or another mineral component such as sand during hide working may lead to extreme rounding of the tool's edge. Still, the intensity of the rounding, and thus the macroscopic visibility of this process, is proportional to the intensity and duration of the use of the tool.

However, other activities lead to clear, macroscopically visual rounding. Making fire by using pyrite and flint results not only in a specific gloss, parallel scratches, splintering and little pits, but also in a macroscopic rounding-off of the strike-a-light as the released pyrite dust works as an abrasive on the flint's tip (Stapert & Johansen 1999). Other stone-on-stone activities such as the production of a pit or a perforation in a soft stone artefact or the pulverisation of soft, mineral substances may lead to this phenomenon as well. Obviously, a borer can also be used to perforate hide, bone, antler, wood, or even pottery. All these activities may lead to their own specific polish, scratches, and rounding (Niekus et al. 2002).

Furthermore, as use-wear analysis is dependent on interpretation and analogy, the revealed discrepancy may very well be more than a difference in performed activities. Dissimilar working methods may also influence the outcome of the research.

To conclude the section on rounded pieces, the rounding-off of the tips and fractured ends of the artefacts appear to be indicating towards a use as strike-a-lights and/or some form of hafting arrangement. Traces of hide and mineral substances suggest the variety and complexity of the phenomenon. Even more, the rounding on the lateral edges of two artefacts with visible use-wear traces on site S4 does not point to either of these explanations. This might prove that the cause of rounding is even more varied than initially assumed.

The final analysis on 16 bipolar flakes and blades was conducted in order to verify whether these small artefacts were utilized or not. It is attested that the Dhangar shepherds of India use small, bipolar flakes to castrate lambs (Kosamby 1967: 106, 109). Furthermore, it may be argued that the 'apparent disuse' of the numerous bipolar pieces make a definition as core plausible (see section 3.2.4). The flakes removed from these cores might have been used for all sorts of activities. In order to verify this assumption, the flakes needed to be checked for traces, therefore the analysis was thought to be useful.

Of site S2 three bipolar removals were chosen measuring between 19x12x4 mm and 38x13x4 mm. The material from site S3 is more numerous thus more removals were chosen from this site. They vary from 14x8x2 mm to 35x16x8 mm. The choice was made to employ only

15 Several of the rounded pieces, especially the longer specimens, also showed traces of contact with siliceous plants, hide, and wood on the edges. These could point to two separate events, although some traces revealed a sequential order indicating the re-use of the tools.

fine-grained flint artefacts with well-defined edges that were not damaged by fire. Unfortunately, no use-wear traces were detected on the artefacts. The only exception is a bright spot on the ventral face of a flake which seems to have no clear direction. According to Woltinge (pers. comm. 2008) it cannot be ruled out that it is nothing more than a postdepositional trace.

Thus, the analysis on the small sample of bipolar flakes did not reveal any information at all, except that this sample appears not to have been used.

5.4.4 Conclusion

The old and new use-wear analyses combined give a clear view of the variety of activities performed at the different sites at Swifterbant. Several different types of artefacts and tools, including blades, retouched pieces, artefacts with visible use-wear traces, bipolar pieces, and rounded pieces, revealed a wide combination of traces. At site S2 mainly evidence of the cutting and scraping of (soft) siliceous plant materials and hide processing were attested, with to a lesser extent bone / antler and wood working. These traces were also observed at site S4 and S51. At site S51 other activities may have been going on as well as up to 50% of the traces could not be identified. The observed activities on site S3 seem at first sight somewhat less varied as mainly the scraping of siliceous plant material was detected. Yet, the bipolar and rounded pieces reveal much more. Activities such as scraping and cutting hide, in combination with a mineral substance but also piercing hide and engraving bone or antler, point towards the highly domestic character of the site. Additionally, if the research by Bienenfeld had extended to material from site S3 as well, more evidence of soft plant and hide processing, combined with bone / antler and wood working, might have been found. However, van Gijn points out that at the time of research the method of use-wear analysis was still in its infancy (van Gijn 2010).

The absence of sickles, i.e. blades with a clear sickle polish, does not need to imply that cereals were not harvested. Phytolith analysis revealed that no clear evidence of domesticated grains was found, although it might very well be possible that the plant material grown on the hoe-field were early cultivars. Additionally, a different harvesting method may have led to traces different that the 'classic' polish making it hard to interpret the traces as the result of gathering cereal grains.

5.5 Technological analysis

5.5.1 Introduction

The time when typological flint analysis is the highlight of sophistication is long gone. Artefacts were considered by themselves and studied individually, as if they were little, unique pieces of information, especially formal tools since these were believed to be the only purpose of flint knapping, that is the end product. As a result these tools became the centre of attention relegating all other artefacts to by-products or waste not worth studying in detail. Each artefact, and tools in particular, was considered to have more or less specific morphological features that could be compared to others. Even more, based on analogies with use-wear analyses and experimentally obtained correlates, these tool types were believed to be appropriate only for a single task, a scraper for scraping, a backed blade for cutting (Collins 1975, Stafford 1999). This resulted in an assemblage that consisted of nothing more than a collection of unique pieces, some more alike than others, forming specific tool types with specific functions. This morphological and functional allocation of artefacts to certain types and categories as a sole way of analysing flint assemblages has nowadays long been superseded. Its application and value is, however, not deemed superfluous. As it may lead to an endless division into types diffusing a clear picture and impeding mutual comparison, application to its fullest extent should be performed with caution. Furthermore, as the analysis mainly focuses on the variation of tool types and their mutual quantities while ignoring all the aspects of the process that led to the formation of that specific tool or element, it can be considered a static analysis.

Flint knapping is, however, a dynamic process. It is a sequential procedure consisting of a number of phases in a non-linear arrangement. Flint production needs the critical monitoring of the situation, of the item in hand, and of the decisions adopted throughout the process (Pelegrin 1990). Thus it necessitates constant assessment and re-evaluation in order to create the desired end product. This is as far as all archaeologists working with production processes, *chaînes opératoires* and attribute analyses agree. The multitude of terms and definitions make it a field specific and theoretical discipline.

Over the years, attempts have been made to overcome the static characteristics of morpho-functionalist or typological analysis. Under the influence of criticism from a variety of sources (i.e. Dibble 1984, Hayden 1977, Schott 1986) flint analysts have looked beyond the functionalist approach to stone tool analysis. Restrictions imposed by mobility (Binford 1979 and 1980, Blades 2001, Fisher 2002a and 2002b, Kelly 1983), social territories and boundaries (Wobst 1977), the acquisition of raw materials (Andrefsky 1994 and 1998, Bamforth 1986) and the raw materials themselves, or even skill and dexterity (Bamforth & Finlay 2008, Pelegrin 1990) are taken into consideration. Nowadays, assemblages are regarded as not only determined and affected by the activities for which they were used but also by additional components such as subsistence or economical preferences, social structures and cultural systems. Thus, flint assemblages are, in the words of Stafford (1999) "dynamic reflectors of a greater cultural system" that may provide information on complex social phenomena such as status and social distinction (Gero 1989 and 1991, Hodder 1982, Wobst 1977) or even social behavioural patterns.

This has resulted in the emergence of two methods functioning side by side. The Anglo-Saxon tradition uses the term "tool making trajectory" (Binford 1979, Wiant & Hassen 1985) while the French tradition speaks of "*chaîne opératoire*" (Pelegrin et al. 1988). The Anglo-Saxon organisation of technological approach takes lithic analysis beyond purely functional explanations by integrating lithic data into a wider perspective of cultural behaviour. The emphasis on cultural aspects is expressed by the attempt to elucidate how technological changes reflect large-scale cultural shifts on many levels in prehistoric society (Kelly 1988). The French tradition takes a more social approach. The adaptive nature of human behaviour along with the social context of lithic production and the transfer of knowledge are key aspects. Recently, the concept of *chaîne opératoire* or operational chain (Apel 2008, Schlanger 1994) has been more and more discussed in the Anglo-Saxon literature.

The French ideas and theories on the dynamics of flint production started to develop more rapidly some twenty years ago with the publication of an article by Pelegrin, Karlin and Bodu (1988) on "*Chaînes opératoires*: un outil pour le Préhistorien". The article was based on principles first put forward by Mauss (1935, 1947), Maget (1953), and Leroi-Gourham (1964, 1965, 1993) which were specified by Lemonnier (1976, 1986, 1992). It has been argued that the similarity between human behaviour and flint production is striking. They both follow the same underlying structure being a succession of constant decision making and taking action accordingly. Within this syntactic sequence there are key moments at which significant decisions need to be made, that to a certain extent define the course of further action (Perdaen 2003-2004).

The concept of "*chaîne opératoire*" or "operational chain method" (Apel 2008) takes into account three orders of elements: the pieces or artefacts, the successions of movements or technical sequences, and the specific knowledge of the flint knapper (Pelegrin et al. 1988). These three aspects facilitate the analysis of the production process and the choices and decisions made by the flint knapper at key moments during specific technical procedures.

Perdaen (2003-2004) pointed out that the definition of the term *chaîne opératoire* is used in a somewhat different way by different researchers. In the strict sense the term *chaîne opératoire* is reserved for the sequence of production stages of one single piece of raw material from its first exploitation to its final discard. This is the use of the term as it is defined by Audouze (1999) and Karlin & Julien (1994). But in reality, the reconstruction of the *chaîne opératoire* is often based on the analysis of the assemblage, as the reconstruction of a single piece of raw material is only possible after intensive refitting. The term *chaîne opératoire* is thus often used as a synonym for method or technical process (Perdaen 2003-2004). Also other terms such as method, technique or manner are differently defined by various researchers and their theories and research methods do not pay attention to the same aspects or produce similar technical terms for them. Three terms are clarified here as they will be used in this research:

- Concept: the mental scheme or framework behind the realisation of a product, in other words, the idea behind the method. This idea consists of successive goals or a series of intermediary stages that need to be respected in order to produce the anticipated result (Pelegrin 1985, 1988).
- Method: the specific sequence of production stages according the mental framework that leads to the realisation of the predetermined product. It is a technical procedure that is required to realise the end product.
- Technique: the means used (both objects and specific movements) during the application of the method. That is the way in which force is applied to detach removals, the way in which a core is held, but also the tools used such as hammerstones and antler hammers. Manner or mode of debitage can partly be seen as a component of technique (Perdaen 2003-2004). It is the kind of flaking used to detach removals (Crabtree 1972), such as direct hard percussion, direct soft percussion, indirect percussion, and pressure flaking.

In sum, the total technical system of a prehistoric group at a certain site, by some referred to as technical process, comprises different *chaînes opératoires* (Peeters 2001a, Pelegrin et al. 1988, Perdaen 2003-2004: 20). A *chaîne opératoire* or operational chain is the succession of choices or decisions that lead to a sequence of production stages and its corresponding techniques and products. In other words, an operational chain is a sequence of production stages each made up of a sequence of movements.

5.5.2 Method

During this analysis the potential of the material is tested, results are presented, and ideas are put forward in an effort to gain insight into the production processes and to initiate comparison with other sites. Therefore, attention is paid to the operational chains of three assemblages and to the method applied, and the technique and concept used. Two strictly Neolithic assemblages were chosen, from sites S2 and S3, as these sites are well documented and have an occupation span of only two to three hundred years. The third site (site S61) is not as well documented and has a stratigraphy that is not well recorded. However, a (large) proportion of the flint artefacts are of Mesolithic date, thus providing some comparison with sites S2 and S3.

The technological study is constructed as an attribute analysis since it is a common approach to the study of flint assemblages and debitage remains. In order to select suitable and adequate attributes three major technological publications were primarily consulted. The first publication by Peeters (2001) deals with the flint material from the Late Neolithic site of Mienakker. This work forms the basic principle of a second attribute analysis by Peeters of the Late Mesolithic assemblages at the Hoge Vaart site (Peeters et al. 2001)[16]. These two works were chosen as a primary guideline to the present analysis since a good comparison between both Swifterbant sites and their flint assemblages is required. The third publication by Perdaen (2003-2004) focuses on the Early Mesolithic of Belgium and is very detailed. Therefore, this work was taken as a standard reference to ensure a complete and detailed working method. Practical, detailed attribute analyses and non-theoretical studies on flint technology are not as widespread as typological reports and these three publications were considered relevant to this research. The methodology of each work was compared to that of the others in order to find a common working method that easily could be applied to the flint material from the Swifterbant site. Where necessary, more works were consulted for complementary information on method, applications, attributes and variables (e.g. Inizan et al. 1999, Nishiaki 2000, Tixier 1974).

The chosen attributes for the removals register the longitudinal curvature of the artefacts as well as the cross section and the direction of the detachment. Both proximal and distal terminations are defined. If a butt is present, length and width are measured and faceting and shape are registered. Finally, the delineation of the edges of the artefacts is recorded, as well as the number of dorsal ridges and their pattern.

For the cores and bipolar pieces a different set of attributes was used. These not only describe the general shape of the artefact but also the nature of the striking platform, the location of the production plane on the artefact and the description of the core's sides. Then the shape and the pattern of the removals are defined and finally, the reason for abandonment is determined. For a detailed enumeration of the variables per attribute, and their schematic representations, see appendix 2.

During this study, attention was primarily directed towards the technique applied and not so much to the mode. There were two reasons for this. First, the numerous articles on the formation of flakes and the effect of hammer type on flake mass and platform characteristics (Cotterell & Kamminga 1979, 1986, 1987; Dibble & Pelcin 1995; Pelcin 1997a, 1997b, 1997c; Speth 1972, 1974, 1975, 1981) indicate the complexity of the matter, as pointed out by Pelcin (1997a). The specific features that indicate either soft or hard hammer percussion are heavily debated. According to Pelcin (1997c) flake development is a continuous process acting upon the core which does not only produce distinctive flakes but also mixed types. Therefore, assertions based upon one or two singled out features would lead to erroneous definitions. Another influence is the interrelationship of percussion type and technique (Ohnuma & Bergman 1982; Whittaker 1994). Each hammer type is handled in a different way to accommodate certain characteristics that are specific to that hammer type. Second, it is argued here that understanding the schematics and dynamics employed are more important than the use of a soft or hard hammer. It is true that soft and hard hammer use may provide information on mobility and raw material procurement stress (Kuhn 1994, Pelcin 1997b) but other aspects such as differential proportions of retouched tool types (Dibble & Rolland 1992), percentages of natural surface and depletion of cores may provide this information as well. Furthermore, the presence of both hard and soft hammers is attested at the sites. Criteria such as impact point and cone of percussion are therefore not registered. Also, terms such as 'light' and 'strong' longitudinal curvature, that hold information on the use of hard or soft percussion (Hayden & Hutchings 1989), are subjective and individualistic. The individualistic character of an attribute analysis, or any other typological analysis for that matter, cannot be ruled out. Taking exact measurements of certain features and describing angles or curvatures in numeric degrees is a more accurate way of collecting information. The fact that this would be very time consuming and that 'light' and 'strong' are subjective criteria, was the reason why it was not considered in such detail; only the general type of curvature was registered.

We must bear in mind that every analysis is restricted by certain problems and limitations. One of these is the allocation of a feature to a certain attribute. Within an assemblage the variation of features is a natural given fact, therefore the assignment of such a feature, the shape of a butt or the delineation of the lateral edges, is not always self-evident. Sharp and well-defined categories may lead to a large group of 'irregular' or 'indeterminate' pieces. The well-defined types become isolated and are represented by only a low number of specimens resulting in an unrepresentative image. But then again, this does provide information on the assemblage, that it is characterised by a non-systematic or standardised system and that the flint production is somewhat random or arbitrary. Or it may mean that the defined types are too strict.

A second aspect leading to limitations is fragmentation. Again, it is a natural and common occurrence and should therefore not be left out by studying only the intact pieces, even if it may obscure the analysis. As the result

16 For a description of the operational chains at Hoge Vaart see section 6.2.4.

of fragmentation, specific attributes, such as longitudinal curvature, debitage axis, and delineation of the edges, may be compromised. The certainty that the definition is correct diminishes proportionally to the length or completeness of the artefact described.

The selection of artefacts did not proceed entirely at random. If the total number of artefacts from a certain site was limited, as is the case for sites S2 and S61, preference was given to the hand collected finds. These were at the time of the technological analysis already separated into artefacts ≥ 1 cm and < 1 cm which would speed up the process of selection. Of this hand collected material all flakes and blades, damaged as well as undamaged, were selected from both sites. Rejuvenation flakes and blades were considered to hold specific information and were selected as well. As a large number of artefacts with visible use-wear traces were recovered from site S2, it was thought instructive to randomly select half of these artefacts to compare them with the unused blanks. For site S3 the same basic principal was applied. Of the finds boxes with hand collected material artefacts were randomly chosen, ranging from approximately 60 to 90 pieces per box. The abundance of material made it possible to also randomly pick a number of tools, again to compare them to the unused blanks.

5.5.3 Data and analysis

For this analysis, material was chosen from three different sites. Both sites S2 and S61 have a limited number of artefacts and therefore all the finds from both these sites could be included in the study. The abundance of artefacts on site S3 facilitated a random selection of artefacts to complement the material from the two other sites.

The selected material contains flakes and blades, as well as rejuvenation pieces from sites S2, S3 and S61. Artefacts with visible use-wear traces were collected from sites S2 and S3, while cores and tools were selected from site S3 only (table 5.19). This resulted in almost a thousand artefacts suitable for attribute analysis. The limited number of excavated artefacts from sites S2 and S61 resulted in a small sample for each site. In total 144 pieces of debitage material and 19 artefacts with visible use-wear traces were examined from site S2 and 337 pieces of debitage material from site S61. A larger sample was taken from site S3 as artefacts are more abundant. The sample includes 328 pieces of debitage material, 54 tools, 48 bipolar pieces, and 27 artefacts with visible use-wear traces. The last mentioned type consists nearly entirely of blades.

The research results will first be presented for the flakes and blades. All such removals, including those used as blank for tools or the rejuvenation pieces, are included here. Afterwards, the cores and bipolar pieces will be discussed.

Table 5.19 Typological composition of the analysed artefacts per site.

	S2	S3	S61
Debitage material			
Flakes	25	91	193
Flake fragments	55	122	65
Blades	8	40	25
Blade fragments	53	58	40
Rejuvenation	3	7	14
Cores		10	
Tools			
Scrapers		18	
Rounded pieces		1	
Trapezes		1	
Tools on flake		11	
Tools on blade		5	
Tools on other		5	
Indeterminate tools		4	
Indeterminate tool fragments		9	
Bipolar pieces		48	
Visible use-wear	19	27	
Total	**163**	**457**	**337**

Morphology of flakes and blades

The longitudinal curvature of the flake and blade removals is predominantly straight or concave (table 5.20). For the flakes, there are more specimens with a straight curvature than a concave curvature for site S2, for site S3 the opposite is true, and the numbers are equal at site S61. The blades on all three sites are predominantly concave as are the rejuvenation pieces and artefacts with visible use-wear traces. For the tools the case is somewhat different. When the used blanks are predominantly flakes, a straight curvature will dominate, the same applies to the blades with a concave curvature. Thus, for site S2 flakes are more often straight, and blades more often concave, whereas for site S3 flakes are most often concave while the tools on flakes are more often straight; the concave blades largely outnumber the straight blades at site S3. For site S61 the large number of straight flakes is slightly outnumbered by the concave flakes while the concave blades are again more numerous than the straight blades. Furthermore, a limited number of the removals were detached along an internal (frost) fissure and other fragments were considered too damaged to be analysed, all forming the category "not applicable".

17 These flakes and blades also include the rejuvenation pieces and artefacts with visible use-wear traces on flakes and blades. This is so for tables 5.20 to 5.34.

Table 5.20 Longitudinal curvature of the flakes and blades per site.

	Straight	Concave	Distal	Convex	Torque	n/a	Total
S2	57	52	14	9	5	26	163
	35%	32%	9%	6%	3%	16%	100%
S3	91	187	22	45	3	46	394
	23%	47%	6%	11%	1%	12%	100%
S61	94	121	37	39	10	36	337
	28%	36%	11%	12%	3%	11%	100%

Table 5.21 Type of detachment of the flakes and blades per site.

	Axis	Left	Right	n/a	Total
S2	74	28	27	34	163
	45%	17%	17%	21%	100%
S3	230	43	46	75	394
	58%	11%	12%	19%	100%
S61	220	43	53	21	337
	65%	13%	16%	6%	100%

Table 5.22 Delineation of the lateral edges of the flakes and blades per site.

	Div	Conv	Paral	Div - conv	Retouch	Irreg	n/a	Total
S2	5	5	78	7	0	32	36	163
	3%	3%	48%	4%		20%	22%	100%
S3	18	26	162	17	4	83	84	394
	5%	7%	41%	4%	1%	21%	21%	100%
S61	32	25	93	27	0	130	30	337
	9%	7%	28%	8%		39%	9%	100%

Both flakes and blades are generally detached straight along the debitage axis (table 5.21). Only a few are curved to the left or right during removal. The percentages of left or right detachments vary so little that they are considered equally present. The minor dominance of flakes that detach to the right cannot be substantiated.

The delineation of the lateral edges is in general mostly (sub)parallel (table 5.22). This is especially the case for the blades. The image is less clear cut for the flakes which often display an irregular delineation, especially on site S2. Again site S61 forms an exception as it is the only site where the irregular flakes largely outnumber the parallel edged blades.

The removals are mostly characterised by triangular cross sections (table 5.23). If flakes and blades are looked at separately, this picture is less distinct. Although flakes are dominantly triangular, they display a wider variety of cross sections than the blades. For example, the high percentages of irregular and lens-shaped pieces from site S61 are essentially the result of the flakes. The importance of triangular cross sections can be attested to the advantage of the symmetrical type for site S2 and of the asymmetrical type for site S61 although the differences are small. Site S3 has equally high numbers of both types. The blades follow the same spreading of types as the general tendency. However, on site S61 this is not the case. Here the blades are mostly symmetrical while the dominance of asymmetrical cross sections is the result of the high number of flakes. This predominance of triangular cross sections is very distinct for site S61, contrary to sites S2 and S3 where blade fragments are also often trapezoid.

The number of dorsal ridges is rather varied both between the sites as well as between the flakes and blades (table 5.24). In general two ridges dominate on sites S2 and S3, while on site S61 one ridge is more common. Still, everything between zero and three ridges is well represented. For the flakes it is often zero, one or two ridges depending on cortical presence and for the blades two or three dorsal ridges appear to be the norm. Yet, site S61 has mostly

Table 5.23 Type of cross section of the flakes and blades per site.

	Tr sym	Tr as	Rect	Trap	Lent	Irreg	n/a	Total
S2	49	23	3	36	10	24	18	163
	30%	14%	2%	22%	6%	15%	11%	100%
S3	93	87	10	61	28	56	59	394
	24%	22%	3%	15%	7%	14%	15%	100%
S61	65	89	4	15	56	87	21	337
	19%	26%	1%	4%	17%	26%	6%	100%

Table 5.24 Number of dorsal ridges of the flakes and blades per site.

	0	1	2	3	4 or more	n/a	Total
S2	30	25	58	44	3	3	163
	18%	15%	36%	27%	2%	2%	100%
S3	49	97	120	87	25	16	394
	12%	25%	31%	22%	6%	4%	100%
S61	80	116	99	25	12	5	337
	24%	34%	29%	7%	4%	1%	100%

Table 5.25 Dorsal ridge pattern of the flakes and blades per site.

All	Straight	Half	Quarter	Q + H	n/a	Total
S2	86	16	16	0	45	163
	53%	10%	10%	0%	27%	100%
S3	210	46	37	6	95	394
	53%	12%	9%	2%	24%	100%
S61	144	26	53	5	109	337
	43%	8%	16%	1%	32%	100%

Flakes	Straight	Half	Quarter	Q + H	n/a	Total
S2	28	13	6	0	33	80
	35%	16%	8%	0%	41%	100%
S3	101	30	28	4	50	213
	48%	14%	13%	2%	23%	100%
S61	108	22	40	2	86	258
	42%	9%	15%	1%	33%	100%

Blades	Straight	Half	Quarter	Q + H	n/a	Total
S2	44	1	7	0	9	61
	72%	2%	11%	0%	15%	100%
S3	74	9	4	1	10	98
	76%	9%	4%	1%	10%	100%
S61	34	3	10	0	18	337
	52%	5%	15%	0%	28%	100%

zero, one or two ridges for its blades as well as for its flakes implying there are more cortical blades on the site than on the other two sites. Another observation is that on site S3 more blades have one ridge than on site S2 where two or three ridges for the blades appear to be the rule.

Table 5.26 Type of proximal termination of the flakes and blades per site.

	Butt	Dam	Step	Retro	Hinge	Retouch	Splint	Irreg	Potlid	n/a	Total
S2	77	16	25	17	1		1	2	24		163
	47%	10%	15%	10%	1%		1%	1%	15%		100%
S3	189	55	65	25		16		12	22	73	457
	41%	12%	14%	5%		4%		3%	5%	16%	100%
S61	226	61	21	17	1			5	6		337
	67%	18%	6%	5%	0%			1%	2%		100%

Butt: butt, Dam: damaged, Step: step, Retro: retroflexed, Hinge: hinge, Retouch: retouched, Split: splintered, Irreg: irregular, Potlid: potlid, n/a: not applicable.

Table 5.27 Type of distal termination of the flakes and blades per site.

	Fe	St	Retr	Hi	Pl	Str	Im	Sp	Ir	Po	Re	n/a	Total
S2	26	36	26	10	5	3	5	4	8	40			163
	16%	22%	16%	6%	3%	2%	3%	2%	5%	25%			100%
S3	93	94	40	30	14	8	33	1	22	32	16	74	457
	20%	21%	9%	7%	3%	2%	7%	0%	5%	7%	4%	16%	100%
S61	179	37	33	38	15	7	4	2	16	6			337
	53%	11%	10%	11%	4%	2%	1%	1%	5%	2%			100%

Fe: feather, St: step, Retr: retroflexed, Hi: hinge, Pl: plunging, Str: striking edge, Im: impact point, Sp: splintered, Ir: irregular, Po: pot-lid, Re: retouched, n/a: not applicable.

Table 5.28 Shape of the butt of the flakes and blades per site.

	Linear	Punctif	Hors	Tria	Trap	W-sh	Cres	Asym	Irreg	Total
S2	18	14	7	10	2	1	6	11	8	77
	23%	18%	9%	13%	3%	1%	8%	14%	10%	100%
S3	71	38	9	28	2		4	10	27	189
	38%	20%	5%	15%	1%		2%	5%	14%	100%
S61	26	49	2	26	8	1	3	9	102	226
	12%	22%	1%	12%	4%	0%	1%	4%	45%	100%

Lineair: linear, Punctif: punctiform, Hors: horseshoe, Tria: triangular, Trap: trapezoid, W-sh: w-shaped, Cres: crescent, Asym: asymmetrical, Irreg: irregular.

Table 5.29 Shape of the butt (side view) of the flakes and blades per site.

	Straight	L. conv.	St. conv.	Irreg.	Spur	Total
S2	42	10	21	3	1	77
	55%	13%	27%	4%	1%	100%
S3	92	20	77			189
	49%	11%	41%			100%
S61	142	2	82			226
	63%	1%	36%			100%

Straight: straight, L conv: light convex, St conv: strong convex, Irreg: irregular, Spur: spur.

The overall pattern of the dorsal ridges indicates that approximately half of the cores were not reoriented during debitage (table 5.25). When viewed in detail the flakes show more variation than the blades. These latter have for approximately 75% of the time negatives in the same direction as the detachment itself. This is only 50% for site S61 where a large number of dorsal patterns could not be discerned. If blade cores are reoriented, it is more often a quarter turn for sites S2 and S61 and half a turn for site S3. For the flakes, opposing and crossed dorsal negatives occur for a combined 25% while straight removals appear half of the time. The large number of removals not showing a clear pattern, confuses the picture from site S2.

Approximately half of the removals still possess their butt, whether it is damaged or not (tables 5.26 and 5.27). For site S61 this number is as high as 85%. Distal terminations are for intact removals mostly feathers. When fragmentation occurs, both proximally and distally, this results usually in step fractures or potlidding. The number of other types of proximal or distal terminations varies per site. Steps may also be the result of debitage errors or accidents. It is observed that for site S2 the extensive heat exposure led to a high percentage of fragmentation and to a large number of potlid terminations. The low number of fragmentations on site S61, and of the flakes in particular, is in its turn responsible for the high percentage of feather terminations on that site. Plunging removals and hinges appear only rarely indicating a low number of debitage errors or accidents.

Morphology of butts and bulbs of percussion

For one of the last attributes, the shape of the butt, the distinction between sites S2 and S3 on the one hand and site S61 on the other hand, is rather pronounced (table 5.28). The dominance of linear and punctiform shapes are on site S61 totally outnumbered by the irregular butts. Still, they both are, along with the triangular butt, frequently seen shapes. The variety of the shapes seems to be equally present within the flakes and the blades. The distribution of the second aspect of the shape of the butt, the side view, gives roughly the same picture for the three sites (table 5.29). Sites S3 and S61 are very similar with straight and strong convex delineations forming 98% of the butts. For site S2 this is only 80%. The third dominant shape is light convex, on site S2 only a few other delineations occur. The type concave is not attested.

Although the definition of the dimensions of the butt into length and width (Peeters 2001a) is a more logical one - it is after all a two dimensional surface - the terms width and thickness are used here for easy comparison to most studies. To avoid unnecessary confusion, the thickness of the butt[18] is the distance measured from the dorsal face to the ventral face while the width[19] is the distance measured from one lateral edge to the other (figure 5.33). Several of the measurements are 0x0 mm as the result of

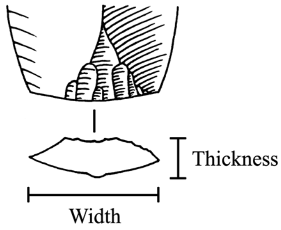

Figure 5.33 Schematic representation of the butt.

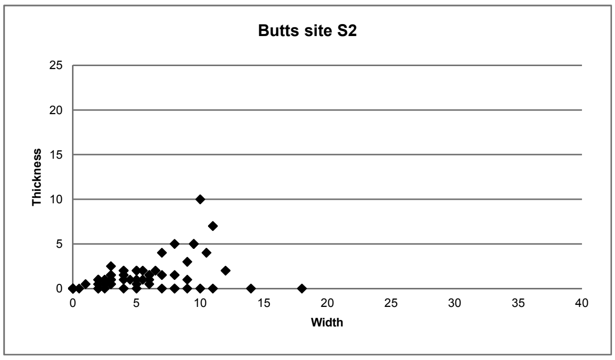

Figure 5.34 Dimensions of the butt of the flakes and blades of site S2.

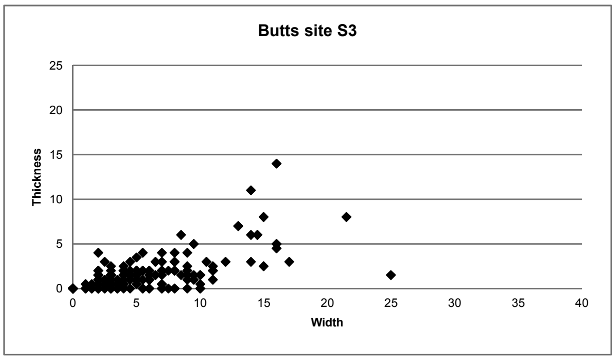

Figure 5.35 Dimensions of the butt of the flakes and blades of site S3.

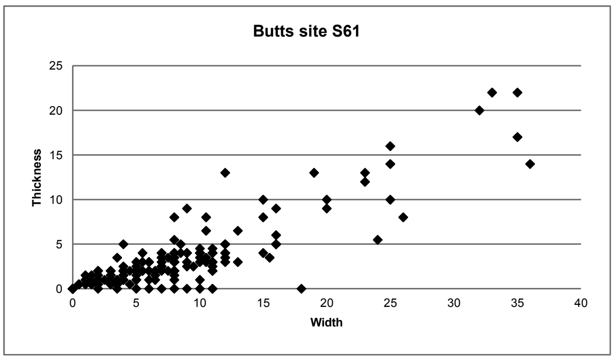

Figure 5.36 Dimensions of the butt of the flakes and blades of site S61.

18 Peeters refers to this distance as ‘width’ (2001: 583).

19 Peeters refers to this distance as ‘thickness’ (2001: 583).

Table 5.30 Dimensions of the butt of the flakes and blades per site.

S2	Min w	Min th	Max w	Max th	Av w	Av th
Flakes	0	0	18	10	4.2	0.8
Blades	0	0	12	5	4.8	1.3
Rejuvenation	4.5	1	4.5	1	4.5	1
Use-wear	2	0.5	11	7	5.2	2.2
Average					4.5	1.2

S3	Min w	Min th	Max w	Max th	Av w	Av th
Flakes	0	0	21.5	14	5.6	1.6
Blades	0	0	25	3.5	4.3	1.1
Rejuvenation	3	0	14	11	7	3
Tools	2	0	11	3	7.1	1.4
Use-wear	0	0	8	4	5	1.7
Average					5.4	1.5

S61	Min w	Min th	Max w	Max th	Av w	Av th
Flakes	0	0	36	22	7.4	3.1
Blades	0	0	10.5	4	4.3	1.4
Rejuvenation	0	0	15	10	6.3	2.7
Average					6.9	2.8

Min w: minimum width, Min th: minimum thickness, Max w: maximum width, Max th: maximum thickness, Av w: average width, Av th: average thickness.

Table 5.31 Type of preparation of the butt of the flakes and blades per site.

	Plain	Dihed	Facet	Patina	Cortex	Crush	n/a	Total
S2	47	1		6	1	8	14	77
	61%	1%		8%	1%	10%	18%	100%
S3	65	3	3	19	6	23	70	189
	34%	2%	2%	10%	3%	12%	37%	100%
S61	73	12	11	57	22	8	43	226
	32%	5%	5%	25%	10%	4%	19%	100%

Plain: plain, Dihed: dihedral, Facet: facetted, Patina: natural surface (patina), Cortex: cortical, Crush: crushed, n/a: not applicable.

linear and punctiform butts (table 5.30). Still, maximum widths and thicknesses of 36 and 22 mm respectively have been recorded for site S61. When the average widths (lengths) and thicknesses (width) are compared and the dimensions charted (figures 5.34 – 5.36), it can be noted that site S2 has the smallest dimensions of butts, 18 and 10 mm, whereas for site S3 they are larger with maximums of 25 and 14 mm, with site S61 showing the largest measurements of 36 and 22 mm.

It is clear from all sites that most butts are plain, particularly so for the blades (table 5.31). It should be mentioned that the type "not applicable" are linear and punctiform butts that have no faceting due to their limited dimensions. Flakes show a wider variety from not applicable, i.e. linear or punctiform, to crushed or patinated types. The high percentage of plain butts on site S2 diminishes on site S3 and forms a contrast to the variety of butt types on S61.

The shape of the bulb was also recorded and is related to the development or angle of the bulb (table 5.32 and table 5.33). On all sites lightly pronounced bulbs and straight bulbs form approximately 50% of the total. This is also clear in the angle of the bulbs that are generally 90° or 100°. Again, site S3 demonstrates a little bit more

Table 5.32 Shape of the bulb of the flakes and blades per site.

	St pron	Lip	Splint	L pron	Straight	Conc	Ang	n/a	Total
S2	6	8	1	25	20	2	7	8	77
	8%	10%	1%	32%	26%	3%	9%	10%	100%
S3	7	12	2	44	51	24	30	19	189
	4%	6%	1%	23%	27%	13%	16%	10%	100%
S61	12	17		49	58	22	23	45	226
	5%	8%		22%	26%	10%	10%	20%	100%

St pron: strongly pronounced, Lip: lip, Splint: splintered, L pron: lightly pronounced, Straight: straight, Conc: concave, Ang: angular / Hertzian cone, n/a: not applicable.

Table 5.33 Angle of the bulb of the flakes and blades per site.

	40	60	70	80	90	100	110	120	130	n/a	Total
S2			1	4	30	19	10			13	77
			1%	5%	39%	25%	13%			17%	100%
S3		1	4	19	80	41	16	8		20	189
		1%	2%	10%	42%	22%	8%	4%		11%	100%
S61	1	6	8	7	85	44	28	8	1	38	226
	0%	3%	4%	3%	38%	19%	12%	4%	0%	17%	100%

Table 5.34 Impact angle of the flakes and blades per site.

	40	50	60	70	80	90	100	110	120	130	140	n/a	Total
S2	1					33	4	17	7	6	1	8	77
	1%					43%	5%	22%	9%	8%	1%	10%	100%
S3			1	2	2	111	16	26	24	1	1	5	189
			1%	1%	1%	59%	8%	14%	13%	1%	1%	3%	100%
S61		1		5	6	78	21	35	25	17		38	226
		0%		2%	3%	35%	9%	15%	11%	8%		17%	100%

variation than site S2 whereas site S61 shows a larger variety of bulbs ranging from 40° to 130°.

Finally, the impact angle, that is the angle between the butt and the line running from the impact point to the distal end of the artefact (table 5.34). It reflects the detachment angle from the core. The dominance of 90° and 110° angles is general on all sites. The limited range of 90° to 140° is a slightly larger group on sites S3 and S61. The artefact with a 40° angle is an isolated example from site S2.

Morphology of cores and bipolar pieces

The cores and bipolar pieces were analysed using different attributes and are therefore discussed separately. Both artefact types were only available at site S3 and therefore form a tight group. The 11 cores have minimum and maximum measurements of 12x6x8 mm and 56x30x44 mm. For the 48 bipolar pieces these measurements are 12x9x3 mm and 44x26x24 mm respectively.

The cores are defined as one core with one striking platform, four cores with two opposing striking platforms, one core with two crossed striking platforms, four core fragments, and one indeterminate tool for which a core was re-used. The shapes of the cores are widely different. Although pyramid shapes occur most, prismatic, round, lenticular, and irregular shapes are attested as well. This appears to be influenced by the fragmented state of the cores. The nature of the striking platforms is less diverse. The dominance of natural striking platforms, of either cortex or patina, is overwhelming. Only one platform is plain, indicating minimal preparation, and three platforms are reduced to a linear striking ridge. The frontal positioning of the production plane is preferred often in combination with the exploitation of one side. So the sides of the cores may remain cortical, may stay decorticated after initial shaping, or may be part of the production plane. All but one of the production planes show exclusively flake detachments. The core with two crossed striking platforms is the exception with a combination of both flake and blade scars. This is not the only reason why it is exceptional. As the definition implies, the two striking platforms are the result of a quarter turn of the core. This type of core is not represented in the typological list in the catalogue (figure 2.12) because cores with four faces are not listed. It can be described as a combination of type 111 and type 31, with both platforms transversely oriented to one another and only having detachments in one direction. Only one other core shows the re-orientation by a quarter turn. All the others are unidirectional or have opposing platforms. The exact measurements of the flake and blade negatives were not recorded but it was noted that the flake scars in particular only cover half the length of the production planes. Finally, the reasons for abandonment are often a faulty exterior platform angle, whether or not combined with debitage errors. Impurities in the flint led to the abandonment of only one core.

The larger group of bipolar pieces are divided into 21 regular pieces, 16 irregular pieces, and 11 square pieces. Still, they are all analysed in the same way as the cores. The general shape of the pieces is predominantly lenticular, mostly with two faces. The only exceptions are those with triangular cross sections, which have therefore three faces, and fragmented pieces. Still, all platforms are linear. Production planes mostly cover the full two or three faces; in 17 cases some part of the artefact is unaltered resulting in patches of natural surface. The detachments are predominantly flakes; in only 11 cases was a combination of flake and blade negatives visible. These flakes are detached in a bipolar way with the two striking edges in opposing positions. This is by far the most common pattern, both for two faced pieces and for three faced pieces. A handful of bipolar pieces are, however, reoriented by a quarter turn during debitage resulting in the transverse location of the second set of striking edges. The measurements of the flake and blade negatives were not recorded but the typological designation implies flakes running the full length of one striking platform to the opposing one for the regular pieces and only half the length for irregular and square shaped pieces. The abandonment of the bipolar pieces was often related to debitage errors such as stacked steps or hinges, the limited size of the pieces, a faulty exterior platform angle, or a combination thereof.

5.5.4 Interpretation

Step by step, a consideration of the attributes will be made in order to compare and define any similarities or differences between the three sites. As with the presentation of the results above, the interpretation will also be separated into a section on flake and blade removals and a section on cores and bipolar pieces.

Flakes and blades

Straight and concave longitudinal curvatures occur most often. In general, flakes from sites S2 and S3 are more often straight whereas blades are more often concave. These two curvatures also predominate on site S61 but flakes are equally often concave, or even a bit more, and blades are also very often curved distally. The relationship between the longitudinal curvature of the production plane and the limited length of the flakes compared to the blades is of importance here. Andrefsky pointed out that surface morphology of the core contributes to the extent of curvature found on flakes and blades (1986: 52). So it is not that hard to imagine that flakes are not as curved since they have only a limited length. A straight delineation is also a feature of bipolar debitage technique. Still, to imply that all straight detachments are bipolar would be an overstatement as other features need to be present to define a removal as bipolar. Furthermore, longitudinal curvature is of major importance with regard to the selection of flakes and blades as usable blanks for tool production or use in an unmodified form. It also provides information on the stage of reduction in blade production (ibid: 48). As the percentages of the curvatures of the tools are equal to those of the debitage material one might suspect that the debitage production was in correspondence to the needed blanks or that the produced blanks were sufficient for the required activities.

The impact blow to detach both flakes and blades is primarily located behind the dorsal ridge, producing mostly straight removals with triangular cross sections. Only a minority of the blades, and then especially from sites S2 and S3, are detached by a blow between the ridges resulting in a trapezoid cross section. For the flakes the position of the impact point may vary more as irregular and lens-shaped cross sections also occur. Furthermore, removals detaching to the left or to the right instead of straight happen now and again. This indicates their lateral position on the production plane forcing them to detach obliquely across this plane (Perdaen 2003-2004). Yet none of these removals has a torque longitudinal delineation, which according to Perdaen signifies a transversal curvature of the production plane. This implies that the cause of oblique detachment is possibly not the result of bend production planes but might be indicative of a somewhat oblique blow to the striking edge.

The number of dorsal ridges corresponds well to this conclusion as two ridges appear most often on sites S2 and S3, while on site S61 one ridge is more common. Yet, the tendency that flakes have between zero and two ridges and blades have two to three ridges tends to hold only for site S2.

The blades generally have parallel edge delineations while flakes are mostly irregular or parallel shaped. The relation between parallel edges and a trapezoidal cross section was observed on sites S2 and S3. This correlation is already attested in the work of Owen (1988). She also writes that trapezoidal blades are generally thinner than triangular cross sections, an aspect also seen in this analysis[20]. The abundance of irregular flakes over all other represented types of delineations is quite exceptional on site S61. According to Patterson (1983) irregular delineation of removals can be associated with a hard hammer.

The dorsal scar pattern indicates that blades are mostly detached without reorientation of the core, thus using a unidirectional technique. However, when blade cores are reoriented, this is only a quarter turn on sites S2 and S61 while half a turn dominates on site S3. Unidirectional detaching only occurs half the time for the flakes, these are also often detached using bidirectional or transverse blows indicating a quarter or half a turn during debitage to maintain the production plane and striking edge angle.

It was argued that the high heat exposure on site S2 was the cause of the high number of potlid terminations. The high number of butts on site S61 is presumably related to the low fracture percentage of the flints from that site. These two aspects are possibly of some importance for the next few paragraphs as number is vital for comparison and statistical assessment. Still, the visible trends possibly do reflect the tendencies present at the sites.

Intact flakes and blades generally end in feather terminations. Step and retroflexed terminations, together with potlidding are the most common fracture types. Still, it is remarkable that a wide variety of distal terminations is visible. Whether this is related to the poor quality of the raw material, as step fractures often are (Peeters 2001a), the angle between platform and production plane, the angle and force of impact on the platform (Pelcin 1997a, 1997b, 1997c), or the presence of cortex (Perdaen 2003-2004) is unclear.

Butts and bulbs of percussion
The dominance of linear and punctiform butt shapes on sites S2 and S3, along with the small dimensions of the butts, are indicative of tangential or peripheral debitage (Pelegrin 1995, Renard 2002). The impact blow is positioned as close to the edge as possible. As the cores are rather small, this might be an attempt to handle the raw material economically. The small dimensions of the butts are possibly also related to the small dimensions of the removals. The size of the butt diminishes in proportion to the size of the artefact (Dibble 1995, Dibble & Pelcin 1995), a feature often observed in this study as well. On site S61 the irregular butts outnumber the linear and punctiform ones. A possible explanation would be abrasion of the striking edge, but since this has not been recorded, this hypothesis cannot be confirmed nor refuted. The presence of triangular butts can be related to the position of the impact point that is often positioned behind the dorsal ridge. As trapezoidal cross sections also occur, one might expect trapezoid butts. This relationship is, however, not seen.

The dominance of plain butts indicates the preference of plain and simply applied platforms. Especially for the blades this sort of preparation seems to be standard for sites S2 and S3. Linear and punctiform butts indicate blows nearer to the edge. The variety of butt types on the blades from site S61 is almost as varied as for the flakes. The presence of patinated or cortical butts for the flakes indicates no preparation at all. The opportunistic way of debitage, to use a natural platform when one is readily available, is suggested by this. Still, dihedral and facetted butts on site S61 give the impression that on certain cores or at certain production stages, more attention was given to the preparation of platforms. That flakes have more often patinated and cortical butts indicates that decortication and the opening of debitage was more often done with flake technique[21]. Once a platform was instated, blades could be more easily produced, resulting in a higher percentage of plain butts.

To determine the applied manner and technique, several features need to be analysed and combined. By themselves, none of these attributes are decisive enough; it is the combination of them that leads to positive results. Yet, the effectiveness and the conclusiveness of the method leave much to be desired. Even so, the technique and mode used to detach both flakes and blades was presumably similar. The shape of the bulb is lightly pronounced and straight approximately half of the time. This corresponds well with the angle of the bulbs that are generally 90° or 100°. It is in different technical attributes related to the butt and bulb of the artefacts, that site S3 demonstrates a little bit more variation than site S2 whereas site S61 shows a greater variety.

Debitage errors
There are indications of debitage errors even if they are limited. The presence of hinge terminations indicates

20 The average thickness of the blades with trapezoid cross sections and those with triangular cross sections is 3.36 mm versus 4.03 mm for site S2, 3.17 mm versus 3.57 mm for site S3, and 3.00 mm versus 3.75 mm for site S61.

21 This is also established by the dominance of decortication flakes over decortication blades. Another factor to be taken into account is that decortication flakes or decortication blades are more likely to have patinated or cortical butts than flakes and blades with less cortex or patina on their dorsal surface.

mistakes in the direction of force (Pelcin 1997c: 1107) or the amount of force applied, and may even be the result of the insufficient weight of the hammerstone (Sollberger 1994: 18), while step fractures are the result of changes in the amount of force (Pelcin 1997c: 1107). Although the impact blow and point itself on sites S2 and S3 is often well positioned in the middle of the butt behind or between the ridges, the impact points on site S61 are located towards the left or right edge of the butt. It was also observed that two or three impact points are visible as more blows were needed to detach the flake or blade. The rare appearance of double bulbs confirms this statement. Another debitage error is plunging flakes and blades. These occur occasionally, more often with the regular blades than with the less systematically produced blades; sometimes a part of the opposing striking edge detached as well. Although plunging detachments may be considered as debitage errors, it is also seen as a characteristic of pressure blades. Removals detaching to the left or to the right, instead of straight downwards, happen now and again indicating a lightly oblique blow to the striking edge instead of a straight one. Another observation is the occurrence of obliquely detached rejuvenation pieces. Instead of orienting the impact blow perpendicular to the debitage axis, it is positioned obliquely. Finally, the blade-rejuvenation combinations may also be regarded as debitage errors. Their presence indicates the necessity of a second blow to detach the artefact as the first blow did not detach a sufficient length of striking edge. The frequent detachment of platform rejuvenation pieces or core tablets by a blow to the back of the core, i.e. opposite to the production plane, may presumably be interpreted as a conscious choice and not as a debitage error.[22] According to the research by Sheets (1975) and the experimental study by Nichols & Allstadt on hinge fractures (1978), error rates that stay below 7% or 8% are acceptable even for experienced flintknappers.

Cores and bipolar pieces

The attribute analysis of the cores confirms the image resulting from the typological analysis. Cores are rarely prepared for production. Mostly a natural striking platform is chosen. When a platform is created, this is done by a single blow. Production planes are mostly limited to the front and may sometimes cover the side of the core as well. Therefore, large areas of natural surface remain on the cores. Flakes are the goal of production proven by the lack of blade scars on the examined cores. Their length is mostly half the length of the production plane. The detachment pattern and platform location are mostly unidirectional or opposing and rarely transverse, implying that the production plane was mostly maintained by turning the core half a turn and less often a quarter turn.

Regardless of their typological differences, the bipolar pieces are all very similar. Striking platforms are reduced to linear striking edges. Most pieces have a lenticular shape with two or three faces showing exclusively flake negatives or a combination of flake and blade negatives. These are mostly detached from two opposing directions. In rare cases, the artefact is turned 90 degrees to initiate a second set of striking edges. Half of the time the length of the detachments covers the full length of the production plane while for the rest they cover just half. Although the production planes cover large parts of the bipolar pieces, areas with natural surface still remain suggesting that their current size is not that different from their original size.

5.5.5 Conclusion

During this technical analysis the resemblance between the operational chains of sites S2 and S3 became apparent. It appears they have more aspects in common with each other than with site S61. Unfortunately, the idea of two different operational chains only came to me after the analysis was conducted. Therefore, no distinction was made between the small flakes and blades on one hand, and the large, regular blades on the other. It is true that even without this distinction, technical differences can be observed and should be observed yet maybe not at the right level of detail as one would have obtained when the difference was taken into account.

On more than one level, the attribute analysis shows a relationship between sites S2 and S3 that appears to be different from site S61; although in general the same principles were applied (figure 5.37). The variation within the attributes and thus the debitage is least for site S2. Site S3 shows a bit more variation, yet not as much as site S61. The typological analysis revealed that the flint production on sites S2 and S3 was focused on the knapping of both flakes and blades. For site S61 this seems to be mainly blades. We must bear in mind that sites S2 and S3 are well documented Neolithic sites, while site S61 is not as well documented and has a longer occupation history. Therefore, the differences and similarities should be regarded as indicative.

It was observed that the sites have their own distinctive features. For example, heat exposure was one of the main causes of fracturing on site S2 whereas site S61 has a rather low fracture percentage at the site. These aspects may not be related or have any influence on the operational chains

22 Even though these observations are not strictly related to one of the above analysed parameters, it is believed they might be of some significance, if not for this study, then certainly for future analyses. Other researchers might have encountered the same characteristics, and never mentioned them before, or some people will recognise these patterns in future analyses they might conduct. As these are observations of debitage aspects that rarely make it into scientific articles, the significance of these 'practices', i.e. debitage errors or conscious decisions, is currently unclear.

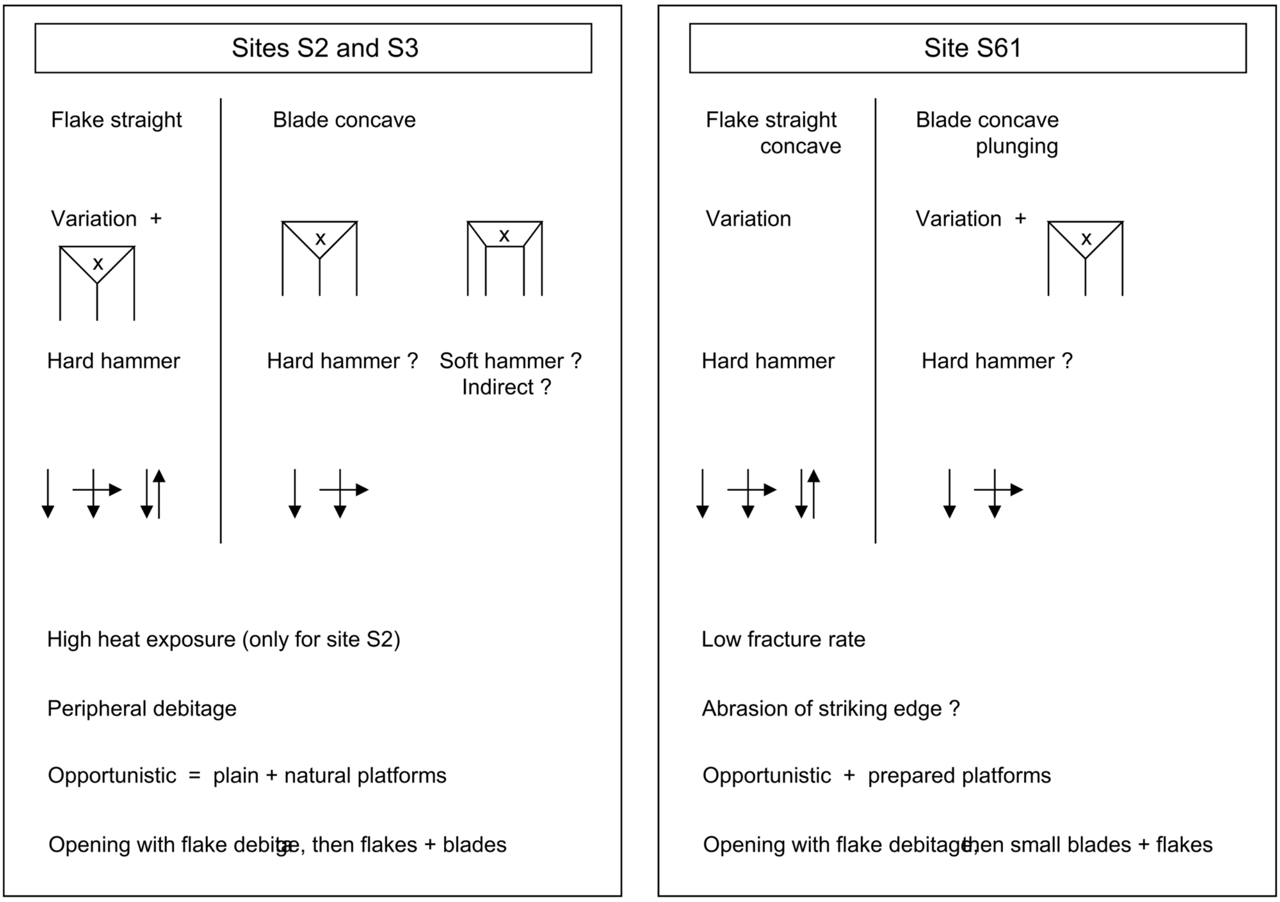

Figure 5.37 Flow chart of the operational chains at sites S2, S3, and S61.

at the sites, yet they signify individual differences that each site might have.

Reduction technique

The preference of minor core and striking edge preparation is proven by the absence of crested blades and the dominance of plain butts. Plain and simply applied platforms seem to be standard for blades on sites S2 and S3. Even more, linear and punctiform butts, together with small dimensions, indicate peripheral debitage. It has been argued that this might be an attempt to economise the raw material, although it also might be related to the limited size of the cores and detachments.

The variety of butt types for the blades on site S61 is almost as varied as for the flakes suggesting there is lesser difference in platform preparation between flakes and blades on this site than on sites S2 and S3. This might enforce the hint of blades being accidental 'blade-like flakes' (see section 3.1.2). Then again, the presence of patinated or cortical butts for the flakes implies that the opening of debitage and decortication was more often done with flake technique. Once the platform was installed, blades could be more easily produced resulting in a higher percentage of plain butts.

The reduction pattern shows that more variation was used for the detachment of flakes than for blades. A combination of unidirectional, bidirectional and cross-directional or transverse debitage was applied to maintain the production plane and striking edge angle by rotating the core a quarter or half a turn during debitage. When blades were detached, most cores were not reoriented, thus indicating unidirectional debitage. However, when they were turned during the knapping process, this is only a quarter turn on sites S2 and S61 while half a turn dominates on site S3.

Morphological characteristics of flakes and blades

The morphological characteristics of flakes and blades on sites S2 and S3 are very similar. Flakes were most often detached by a blow located behind the dorsal ridge. This results in straight removals with straight longitudinal curvatures and triangular cross sections. However, impact points are not always positioned that carefully so irregular and lens-shaped cross sections appear as well. This is also reflected in the occurrence of parallel and irregular edge delineations. For the production of blades more precision was applied. Again, these were mainly detached by a blow located behind the dorsal ridge, producing straight removals with triangular cross sections. Occasionally the blow was positioned between two ridges resulting in blades with a trapezoid cross section. Generally, the blades have a concave longitudinal curvature with parallel edge delineations.

The flakes and blades from site S61 are slightly different in morphological appearance from those on sites S2 and S3. The detachment of flakes was even more carelessly performed as implied by the frequent occurrence of irregular and lens-shaped cross sections together with irregular edge delineations. And even when the impact points were not as carefully positioned as on site S2 and S3, generally the flakes and blades were detached by a blow located behind the dorsal ridge resulting in removals with triangular cross sections. The straight and concave longitudinal curvatures of the flakes might imply smaller cores than on sites S2 and S3. Again, more care seems to have been taken with the production of the blades. They have a concave longitudinal curvature, or a distal curvature, combined with parallel edge delineations. Blows were rarely positioned between the dorsal edges thus blades with triangular cross sections largely outnumber those with trapezoid cross section. This gives the illusion of a less systematic way of creating blades, they appear more like 'blade-like flakes' (see section 3.1.2), although it is presumably just a different technique of producing blades, and not so much less systematic.

Percussion manner
As some of the features of soft and hard hammer mode overlap, it is not easy to set them apart and make exact conclusions. It appears that the lightly pronounced and straight shape of the bulb, combined with the 90° or 100° angle of the bulbs, occurs regularly for both flakes and blades. This would imply a similar technique and mode to detach both flakes and blades. However, the irregular delineation of the flake removals may be associated with a hard hammer technique. Soft hammer technique may apply to blades as these have much more often parallel edge delineations and sometimes even have lips. Still, the technical attributes related to the butt and bulb of the artefacts, demonstrate a little bit more variation on site S3 than on site S2 whereas site S61 shows a larger variety.

The presence of both stone and antler hammers[23] does not help in this matter. It only implies the use of both tools for flint knapping. Noteworthy is the presence of both hard stone (flint) and soft stone (quartzitic sandstone) specimens[24].

23 Stone hammers have been found on sites S2 and S3, antler hammers on site S3 (Bulten & Clason 2001). It is, however, hard to imagine that stone hammers would be totally absent at site S61. Presumably the sample size is the cause of this discrepancy. It is unclear whether antler hammers were ever present at sites S2 and S61.

24 Both types have only been attested at site S3. Again, sample size, i.e. extent of excavations, may be of importance here.

Technological control
In general, flint production was rather well under control. The presence of hinge and step terminations indicates mistakes in the direction and amount of force as do removals detaching to the left or to the right. Sometimes multiple blows were needed to detach the flakes or blades. As error rates that stay below 7% or 8% are acceptable for experienced flintknappers, it is likely that less experienced knappers were present at the sites as step fracture rates run as high as 22%. Still, both intentional and accidental breakage of blades often results in step fractures (Owen 1982) obscuring the debitage errors.

The fact remains that a wide variety of distal terminations is present. To determine what caused this variation, whether this is related to the poor quality of the raw material, the angle between platform and production plane, the angle and force of impact on the platform or the presence of cortex, more detailed research is needed as the material raised more questions than these thousand pieces can answer.

In conclusion, the absence of core preparation and rejuvenation pieces, combined with the limited size of the cores, implies that on the sites no larger material was available. Therefore, the production on the sites was limited to that of flakes and blades of rather small dimensions. The little cores were most likely opened by a single blow in order to decapitate the core and install a simple platform, just like one would do with a soft boiled egg. Alternatively, a single blow could be positioned on a suitable, natural surface or ridge to create some sort of guiding ridge or guiding flake. It is attested that flake debitage was used in the initial stages of reduction, while only little preparation was used for blade production. The limited size of the cores was also responsible for the limited number of removals and rather quick abandonment of the cores since rejuvenation could not successfully be carried out on such small cores. The production planes were instead maintained by reorienting the core a quarter or half a turn.

Furthermore, the presence of natural surface on the bipolar pieces suggests that small nodules were also used for this type of flint production. Still, the flake and blade scars more often cover the full length of the production plane when compared to the platform cores. Even more, it appears that the success rate of usable flakes is higher for the bipolar pieces suggesting that the bipolar technique is a better adapted debitage technique for small nodules.

Finally, as the general morphological characteristics of the blanks and the tools are the same, we might say that the produced blanks were satisfactory or that the debitage production was complying with the needs of the Swifterbant people.

These conclusions clearly indicate the presence of two different production techniques. At the settlement sites small nodules and cores were used. These were knapped in an opportunistic way, by using natural surfaces as platforms, to produce flakes and small blades. Most likely everyone at the settlement could produce their own everyday tools for their daily needs.

A second technique must have been used as well. This technique was not applied at the settlement site, but was used somewhere else, i.e. an 'off-site' location, maybe at the procurement site of the nodules. These 'special' nodules were larger than the nodules used for everyday debitage at the settlement site and presumably specially selected. It concerns big nodules for big cores, knapped by using a specialised technique. It is most likely this was done by certain (specialised) people. It was the specific aim to produce large, regular blades which could be transported to the site, possibly to be used for specific activities.

5.6 Observations on spatial patterning

5.6.1 Introduction

In the past some of the flint material has been studied, mainly by Deckers (1979, 1982). His studies did not only comprise typo-technological analysis but also included some spatial analysis. As most of the spatial information has been lost over time, it is partially Deckers' publications that are used below. Another part of the spatial information used in this section is gathered from de Roever (2004). Finally, some coordinates of three dimensionally registered artefacts, specifically from site S3, did survive and could be used. The spatial information of the new excavations at site S4 are also still available.

5.6.2 Site S2

For site S2 the spatial analysis by Deckers (1979) is valuable, especially since all spatial information on that site is lost to us. Deckers states that all flints seem to be evenly distributed throughout the occupation layer, both vertically and horizontally. This accounts for most of the debitage material and the tools. Yet, a certain concentration is visible when weight is the discriminative factor. The heaviest artefacts seem to cluster at the centre of the site, whereas the smaller artefacts are located at the edges of that area (Deckers 1979: fig. 14-16). As Deckers sees no relation between the distribution of the flint material and the graves, he assumes that most of the material was deposited after the burials. It is indeed true that the area with most of the flint material only coincides partially with the graves. Yet the absence of a spatial overlap does not need to rule out a connection between the two. The same applies to the row of postholes which are located at the edge of the site, outside the area in which the flint was distributed. Had the graves been completely devoid of flint artefacts, one might have had a good argument for the separation of the two events. However, flint artefacts have been found in association with the graves; these might be considered accidental grave filling as they are not the kind of artefacts that are traditionally interpreted as grave goods, thus implying the older age or the contemporaneity of the flint artefacts and the graves.

5.6.3 Site S3

The number of flint artefacts of which the spatial coordinates are still present today is very limited. This is in sharp contrast with the stone industry where 97% of the artefacts could be plotted. The x and y coordinates of most of the hand collected flint artefacts could, however, be retrieved (99%). Then again, the information on the artefacts retrieved from the sieved excavations units is nearly all gone (figure 5.38). As only 3% of these artefacts have their coordinates, this leads to a distorted contour map (figure 5.39). Therefore, the information of the sieved excavations units will not be used in this analysis.

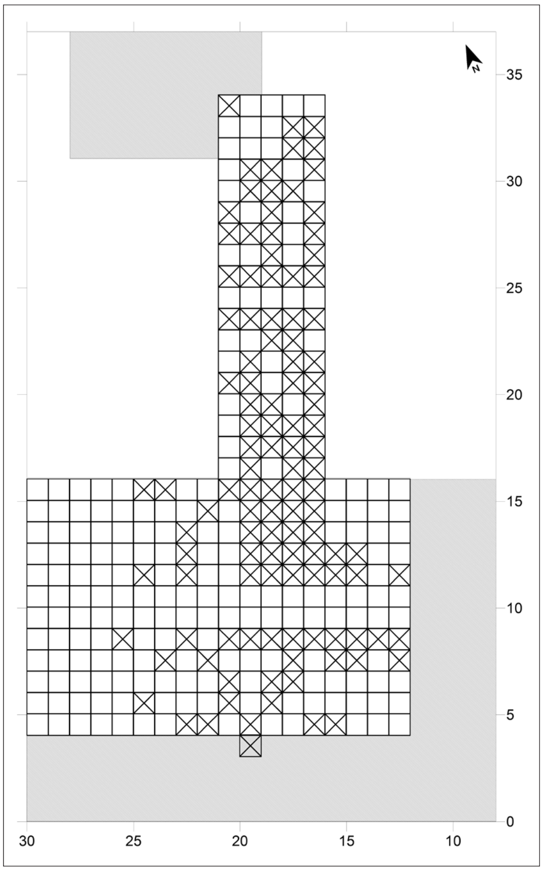

Figure 5.38 Schematic representation of the sieved excavation units within the excavation area at site S3 (black cross: positive on flint artefacts, white box: negative on flint artefacts or no information, shaded part: trench).

As with the stone industry, the third dimension of the three dimensionally registered artefacts, i.e. the depth, could not reliably be integrated in this study. Therefore, the analysis was restricted to a horizontal analysis alone. The information from the spatial analysis by de Roever (2004), and several of her maps, will be used as a starting point for comparison. One of the major contributions

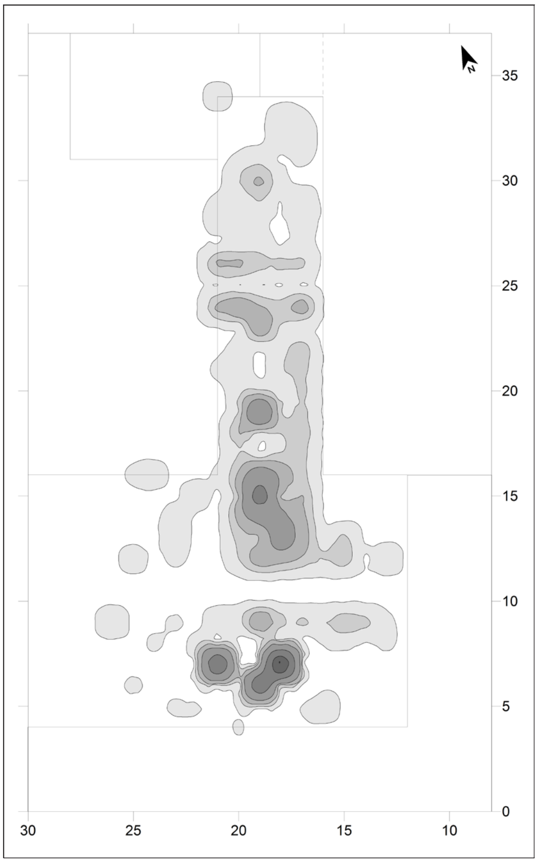

Figure 5.39 *The artefacts (both ≥ and < 1 cm) from the sieved excavation units at site S3, of which the spatial information is still available. Contour lines set at 1, 3, 5, 10, 25, 50, and 75 artefacts.*

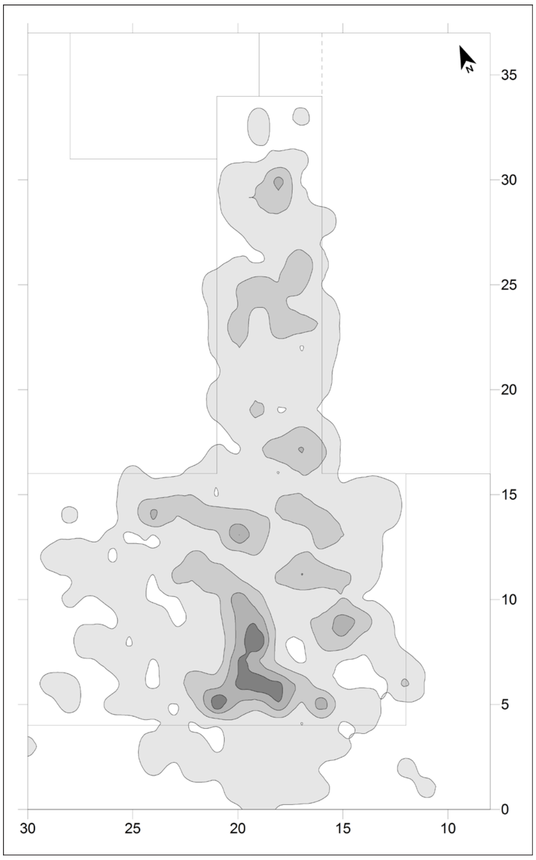

Figure 5.40 *The hand collected artefacts < 1 cm from site S3. Contour lines set at 1, 3, 5, and 7 artefacts.*

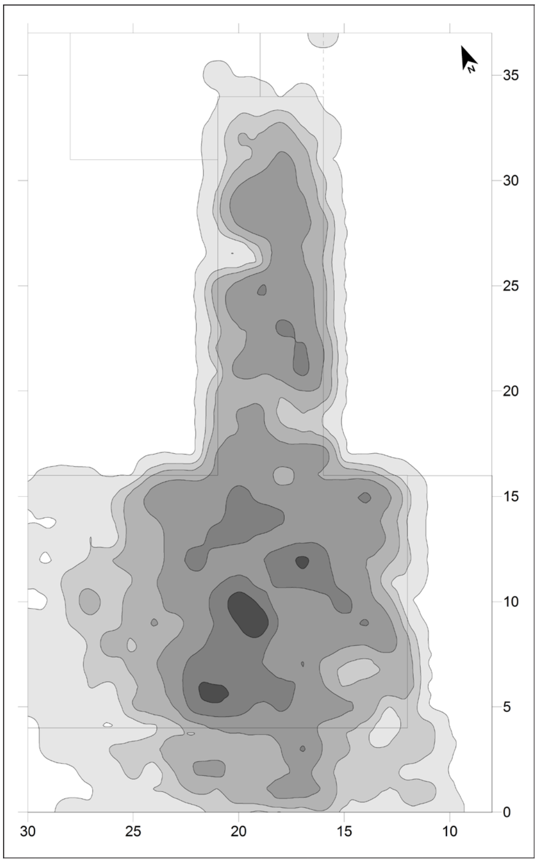

Figure 5.41 *The hand collected artefacts ≥ 1 cm from site S3. Contour lines set at 1, 5, 10, 20, 40, and 60 artefacts.*

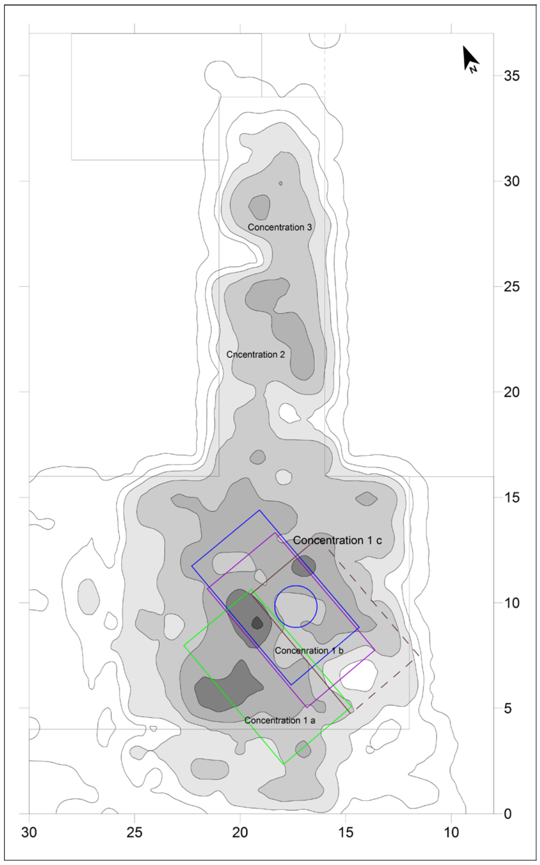

Figure 5.42 *The hand collected artefacts (both < and ≥ 1 cm) from site S3. Contour lines set at 1, 5, 10, 20, 40, 60, and 80 artefacts.*

of de Roever was the discovery of a house on site S3. The horizontal patterning of the stone artefacts (see section 4.7.2) suggested that four different phases of the same house may be reconstructed.

Even when only one dataset is used, i.e. that of the hand collected artefacts, the spatial maps are drawn up in two ways. In the first type of map (classed post map) each artefact is represented by a symbol at the precise location where it was found. This is thus a good way of representing the three dimensionally registered artefacts (see figures 5.43 – 5.44). The second type of map (contour map)[25] draws contours around areas with a certain density of artefacts. These are normally used to represent the sieved material. However, when the coordinates of the three dimensionally registered artefacts are recalculated into that of excavation units, they can be shown in contour maps (see figures 5.39 – 5.42). In that way the amount of flint artefacts per square metre can be analysed.

The amount of hand collected artefacts < 1 cm is limited. Nonetheless, as nearly all of them can be plotted, the image is believed to be as reliable as the excavators were collecting material attentively. Figure 5.40 shows the low density of the finds, yet also shows a few areas with some higher concentrations. When the artefacts ≥ 1 cm are plotted the image becomes more representative as this is a much larger dataset (figure 5.41). It appears that the material clusters roughly at the same locations as the smaller flint artefacts. By plotting all the hand collected material together with the different phases of the house, the clustering occurs around the hearth in 'Pauline's house' [26] and outside the southwestern side of the house (concentration 1a, 1b and 1c, figure 5.42). The house is located on the highest area of the levee. A second elevation of the levee is located in the middle of the trench running north. Two more areas with an increase in the amount of artefacts can be seen near and on this second elevation (concentrations 2 and 3).

Figure 5.42 also reveals that the density of the contour lines at the northern, eastern, and southern edge of the site are located very tightly together. This border effect indicates that the edge of the flint concentration was not reached during the excavation.

Another way of visualising the hand collected material is by 'classed post map'. Each flint artefact, large or small, registered in a three dimensional way is set against the posts and postholes from de Roever's study (figure 5.43). Several voids and concentrations reveal a certain pattern. At the centre of the site a small, roughly rectangular area with less material is visible, with just to the south a clear cluster of material. To the north, at excavation strip XXVII, a second large void can be observed. This is rather irregular in shape. In the area between, a third, possibly rectangular, space also shows less material than its surroundings. Finally, a long rectangular area nearly devoid of finds, running along the 18 m line, indicates the small baulk that was left standing to analyse a long section, whereas the linear area running along the V m line is the gap between two excavation campaigns (figure 5.44). When this image is set against the different phases of the house that were revealed during the spatial analysis of the stone artefacts, it appears the first void reveals the outline of a new phase of the house, smaller than the others (light blue line). The third void might be another outline of a house (black line), yet this is rather vague and not as well supported by the pattern in the posts and postholes as the other houses. The second, irregularly shaped void remains currently unexplained. Of the different phases of the central house, only two house plans show any relation to the flint material (dark blue and brown lines). Clearer is the accumulation of material between the newly discovered (small) house and the edge of 'Pauline's house'.

Even if it proved to be hard to discern patterns when plotting the stone tools, the plotting of the flint tools was even more challenging. It appears the spread of the flint tools is generally the same as that of all the hand collected material (figure 5.45), that is a clustering around the hearth in 'Pauline's house' and in front of the house at the south side. The two clusters more to the north are more vague. The scrapers (figure 5.46, blue) and the retouched pieces (figure 5.46, red) appear to have the same pattern. The borers (figure 5.47, green triangles) and the arrowheads (figure 5.47, blue squares) are mostly located near the central house. The rounded pieces are spread over the whole site (figure 5.47, red dots) while the fragments of polished flint axes (figure 5.47, pink crosses) are very specific: these are nearly all located between lines XX and XXV. Finally, the artefacts with visible use-wear traces (figure 5.48, blue) and the bipolar pieces (figure 5.48, red) are also spread over the whole site.

When the burnt artefacts are plotted against the hearths, it appears that the material is located nearly everywhere (figure 5.49). Some of the material is situated within a hearth, yet more burnt material is lying outside the hearths, which can also be observed for the burnt tools (figure 5.50). The only patterns that may be observed are some concentrations around the central house and the dominance of heavily burnt artefacts in the southern part of the site.

As with the stone artefacts, the final stage of the spatial observations is the comparison of the flint material to the pottery and bone densities. The potsherds (figure 4.21)

25 The contour maps are made using the kriging method.

26 This is the blue coloured house outline. For more information see section 4.7.2 which is the spatial analysis of the stone artefacts.

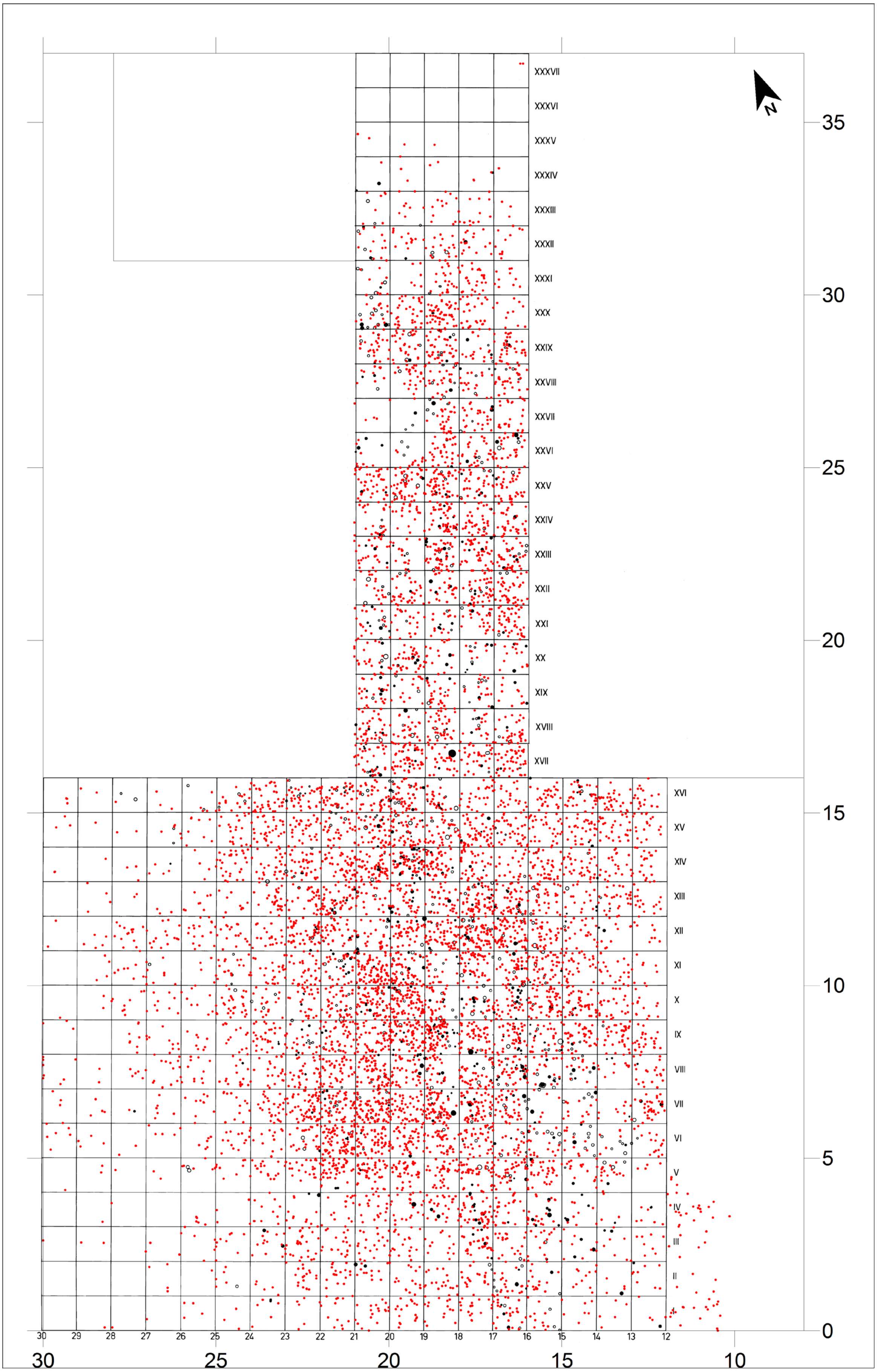

Figure 5.43 *The three dimensionally registered artefacts (both < and ≥ 1 cm) from site S3, combined with the posts and postholes.*

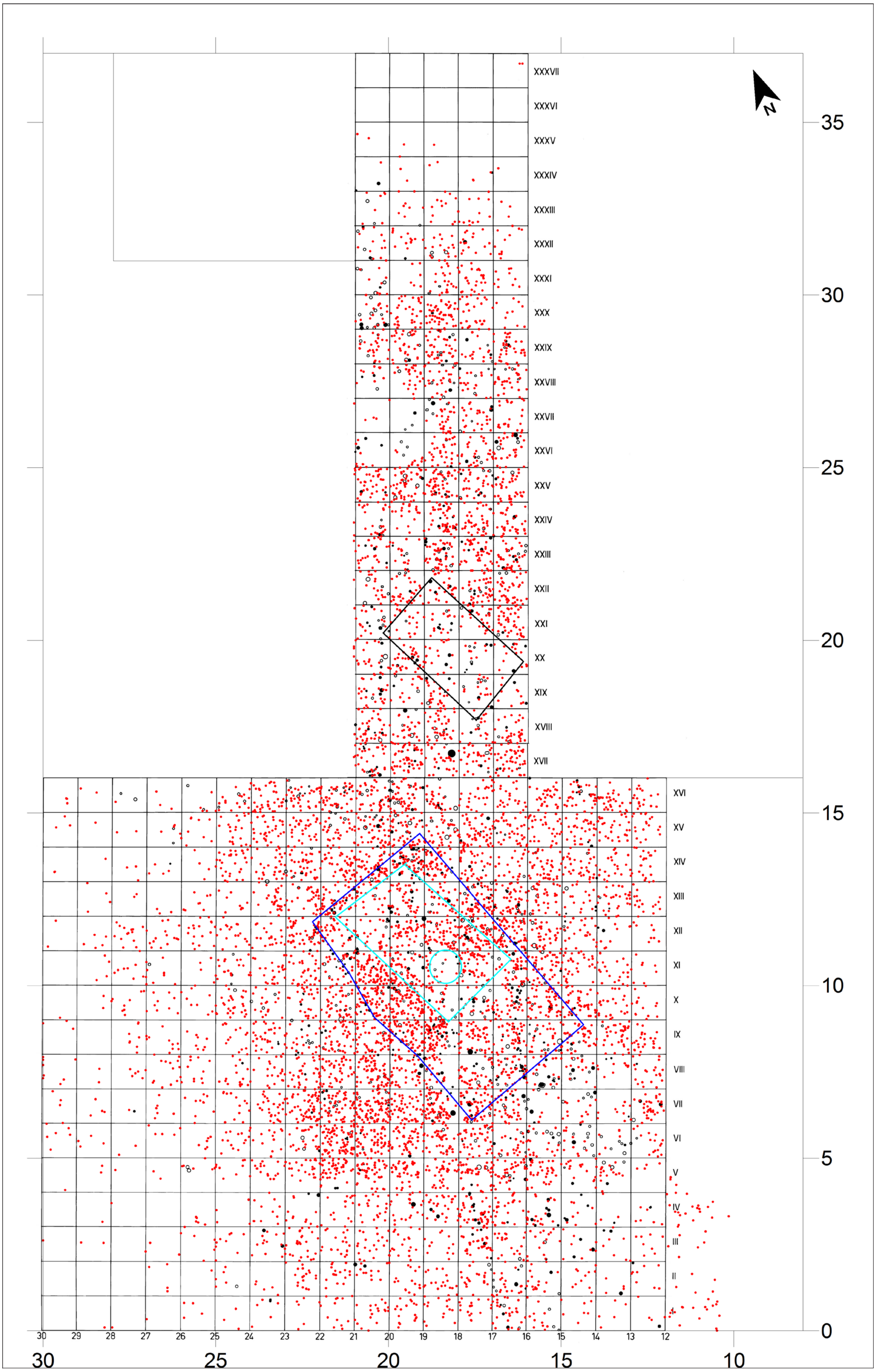

Figure 5.44 The post and postholes from site S3, combined with the newly defined house outlines.

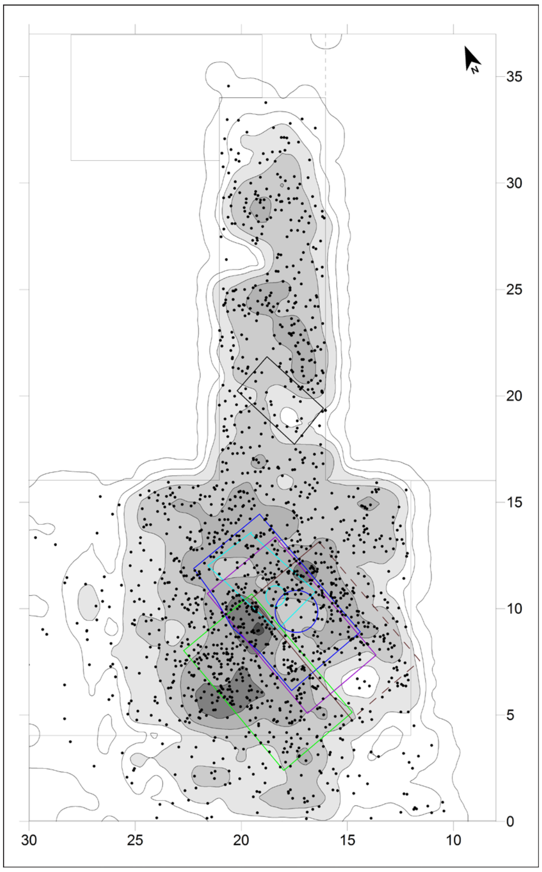

Figure 5.45 *All the tools (black) at site S3.*

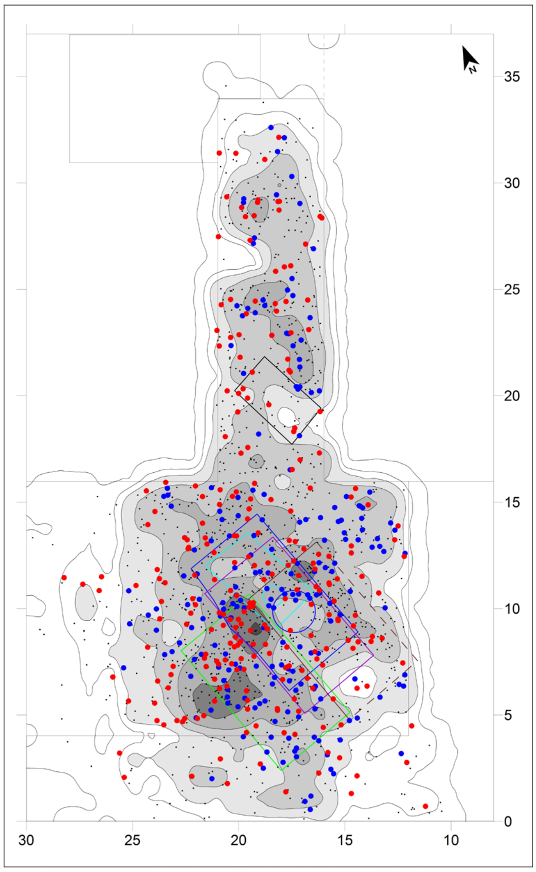

Figure 5.46 *The scrapers (blue) and retouched pieces (red) at site S3.*

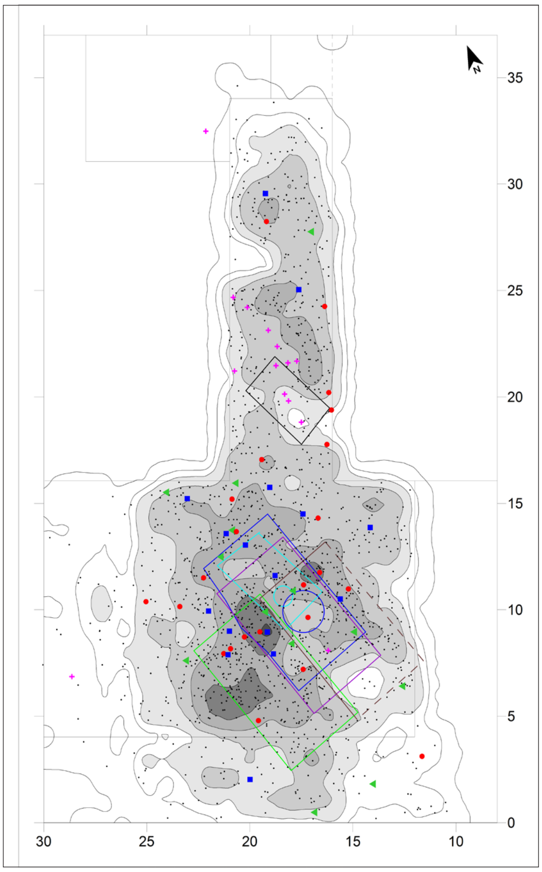

Figure 5.47 *The borers (green), all arrowheads (blue), rounded pieces (red), and axe fragments (pink) at site S3.*

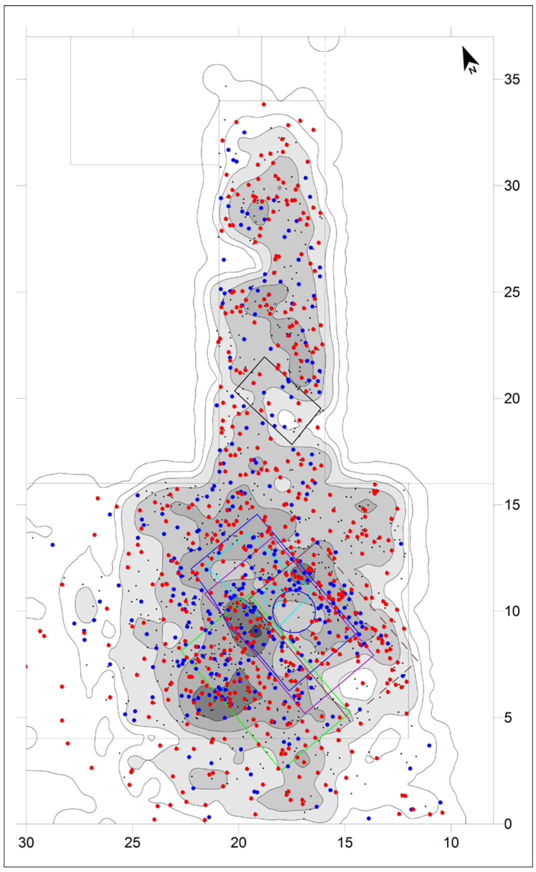

Figure 5.48 *The artefacts with visible use-wear traces (blue) and bipolar pieces (red) at site S3.*

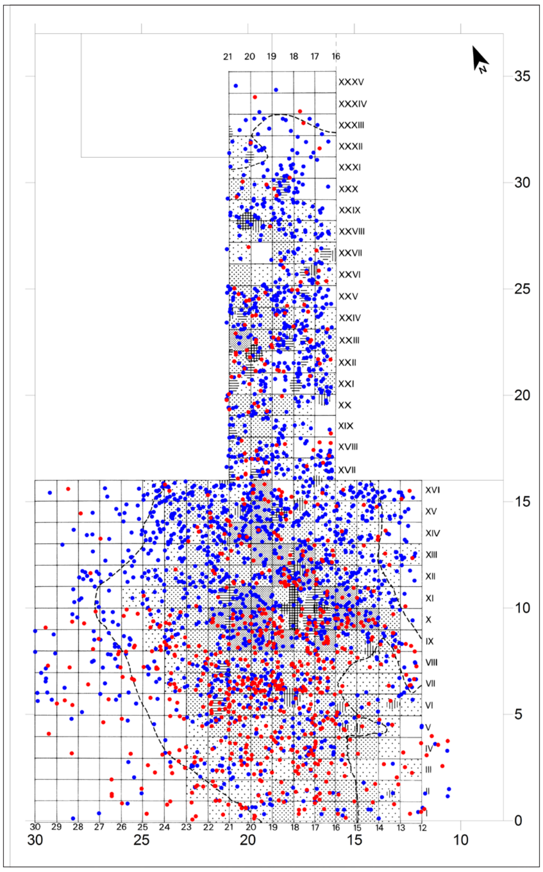

Figure 5.49 All heat exposed artefacts (blue) combined with the heavily exposed artefacts (red) at site S3.

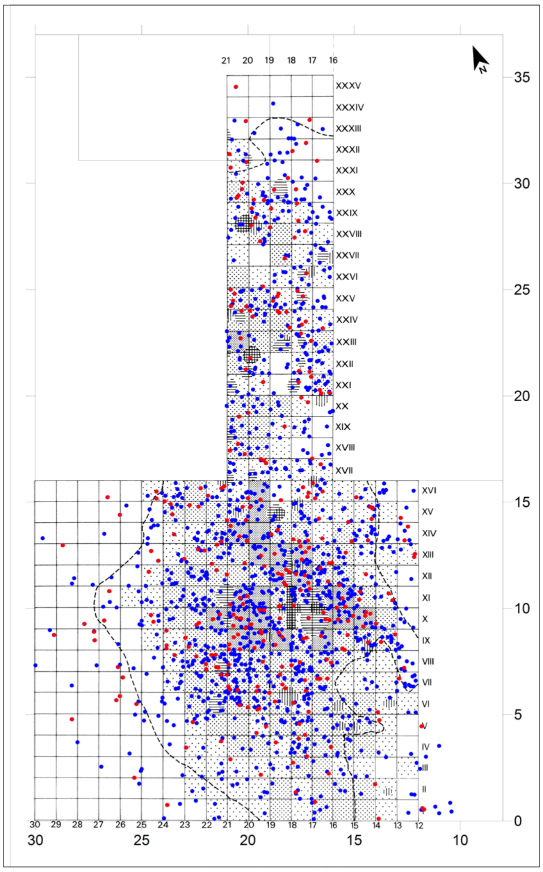

Figure 5.50 The tools (blue) combined with the heat exposed tools (red) at site S3.

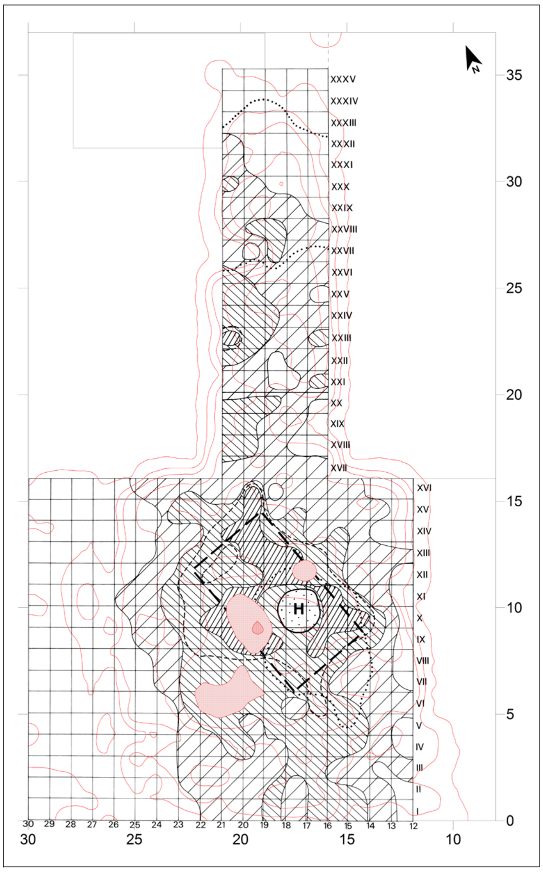

Figure 5.51 The flint artefacts (red) in combination with the pottery at site S3

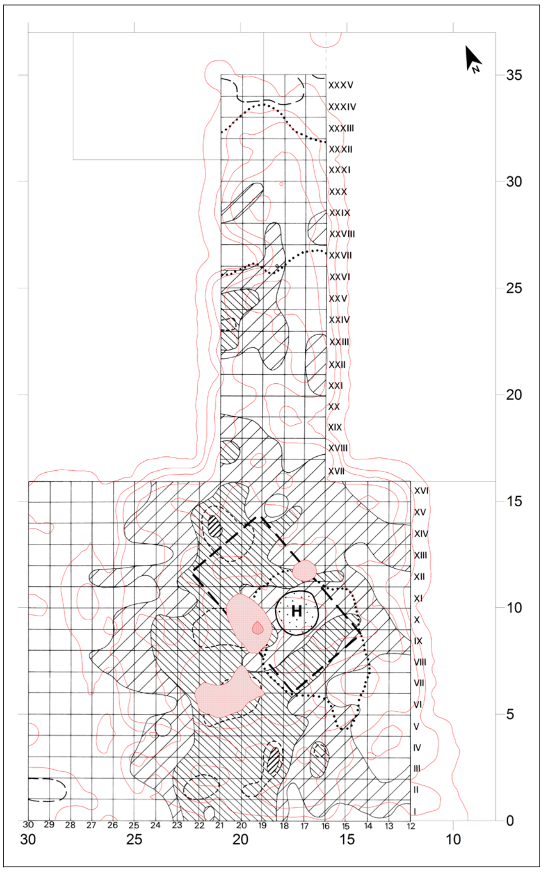

Figure 5.52 The flint artefacts (red) in combination with the bone fragments at site S3

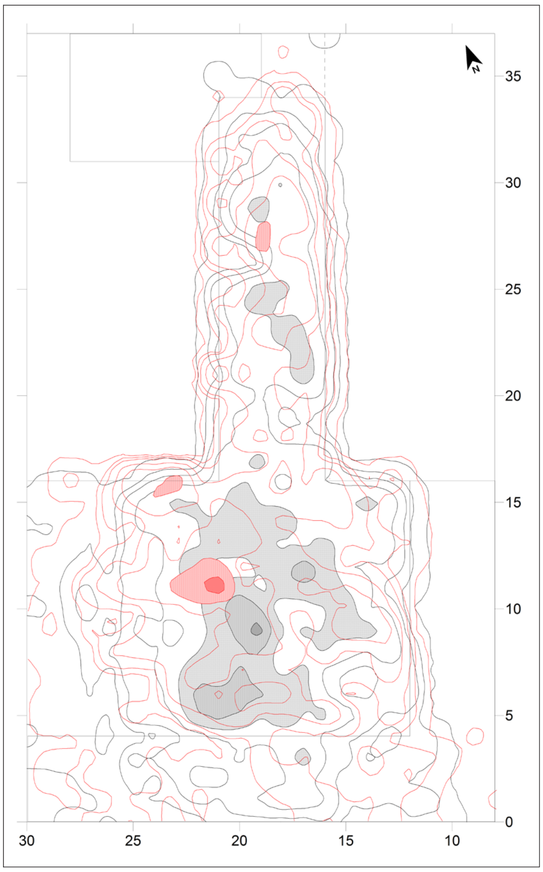

Figure 5.53 Combination of stone and flint artefacts at site S3.

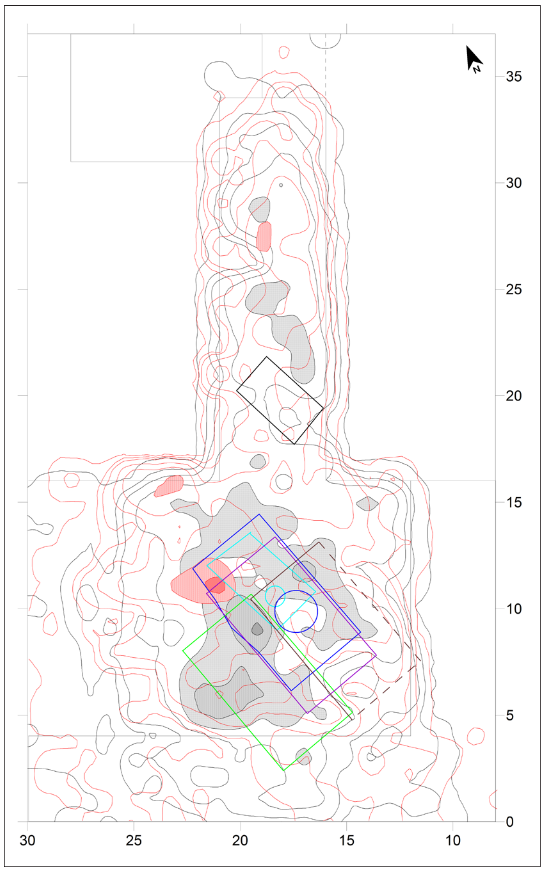

Figure 5.54 Stone and flint artefacts combined with house outlines at site S3.

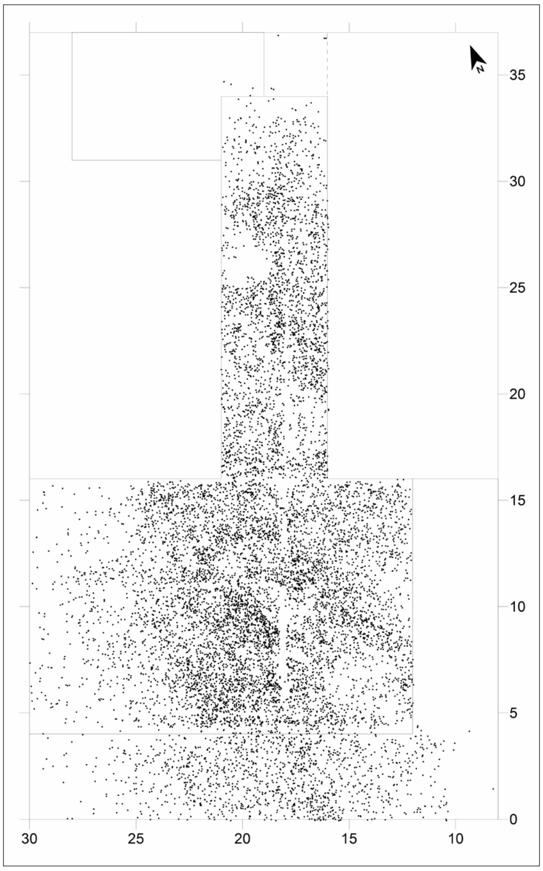

Figure 5.55 The three dimensionally registered artefacts (both stone and flint) from site S3.

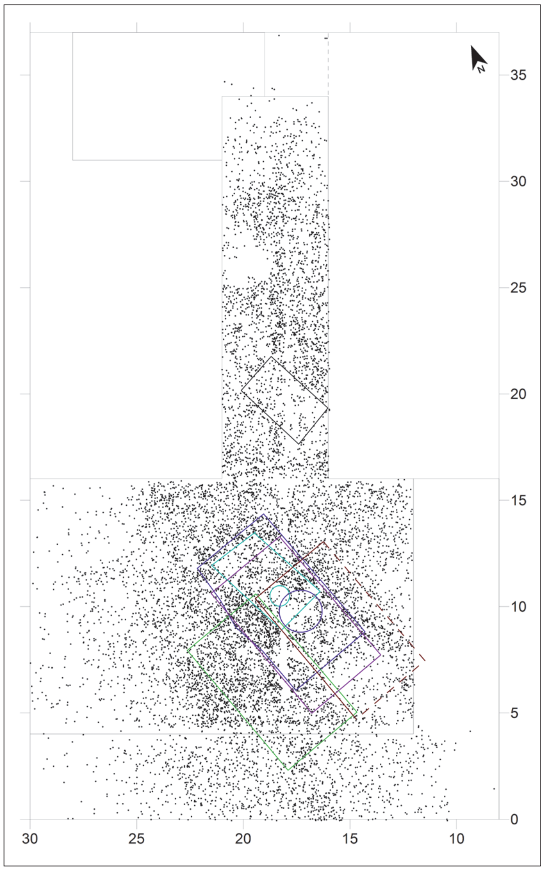

Figure 5.56 The three dimensionally registered artefacts (both stone and flint) from site S3, combined with house outlines.

are most densely spread around the central hearth, mainly inside Pauline's house, and in the lower lying area in the north (line XXIII). It appears the highest densities of the flint material are also located inside the house around the hearth, in similar locations as the pottery (figure 5.51). The flint concentration 1a in front of the house is not corresponding with a pottery cluster, nor are the two flint concentrations in the northern area.

The bone fragments (figure 4.22) have several little clusters of high density outside the house, both in northern as in southwestern direction. Lower densities can be found inside the house around the hearth, in the area around the house also in south(western) directions, and in the lower lying area in the north (line XXIII – XXV). As two of the flint clusters are lying inside the house, these only coincide with lower densities of bone fragments around the hearth (figure 5.52). Yet, flint concentration 1a is located at the same spot as one of the bone clusters. As the higher bone density in the north area is largely similar to that of the pottery, it is located adjacent to the flint artefacts.

To sum up, it appears that the tools are located in the same areas where the other hand collected material clusters, i.e. in and outside the southwestern side of the house. This is related to the fact that the information of the sieved excavation units could not be used in this analysis. It could be asked how representative this image is for the true spread of the flint material. Nonetheless, the material showed a small house present in the centre of the site, perhaps with a doorway at the southwestern side of the house, and possibly even a second house located more to the north. The irregular shaped void at excavation units XXVII could, however, not be explained. Most of the tools appear randomly spread over the site, without showing any special activity areas. Only the borers and arrowheads show some patterning, while the fragments of polished flint axes show the clearest clustering of all.

Comparison between stone and flint artefact patterns

The density of the contour lines at the northern, eastern, and southern edge of the site shows that the edge of the flint concentration was not reached during the excavation. This image is less clear with the stone assemblage, yet is present.

The three concentrations visible within the spread of the stone material are located adjacent to the concentrations of flint (figure 5.53). Stone concentrations 1 and 2 are located north of flint concentration 1b, while stone concentration 3 is located in between flint concentrations 2 and 3. When plotted against the house outlines, the possible second, smaller house is located in between all concentrations making its presence even more likely (figure 5.54).

Furthermore, the stone concentrations do not overlap with the pottery clusters, they are located adjacent to them, just as with the bone material, whereas the flint artefacts seem to be located in the same areas as the pottery, at least inside the house. In the southwestern front of the house the flint concentration coincides with one of the clusters of bone fragments. Yet, in the northern area, the lithic artefacts lie separate from where the pottery and bone coincides. Thus, the flint concentrations sometimes overlap with either the pottery or the bone clusters, whereas stone material clusters in areas where flint, pottery and bone is not concentrated.

When all lithic material is plotted together the patterns become vaguer as the different clusters form one large spread of material (figure 5.55). Some of the house outlines are still clearly visible, while others are blurred. The same accounts for the different stone and flint concentrations. The void inside the house remains whereas now the material clusters mainly in front of the house, at the areas of flint concentrations 1a and 1b. The outline of the second possible house is still not as clearly visible as the main house, but material clusters mainly to the north of it (figure 5.56). When all material is combined, it appears that the spread of the lithic artefacts follows the general topography of the site, thus are located on the highest parts at the west and northern sides of the house, which is located on the top of the levee.

5.6.4 Site S4

For the recent excavations at site S4, campaigns of 2005, 2006 and 2007, the spatial information is available. For the excavation in 1974 this is, however, no longer the case. Therefore, only the 2005-2007 campaign was analysed by J. Geuverink. It appears the excavation trench[27] is located over approximately half of the original site or occupation area. As excavation strips 8 and 9 were excavated with a different technique (sieving of all the collected soil), they yielded three times more material than strips 0 to 7 combined. Even more, strips 0 to 7 increasingly show more material towards strips 8 and 9.

The analysis revealed scattered posts and postholes with similar densities as seen on site S3. They are mainly located south of the 1974 trench. This is also the case for the hearths and hearth dumps, i.e. charcoal marks. Most of the remaining archaeological remains show the same pattern in two different areas. North of the old trench an area with a single hearth and different amounts of flint, stone and bone was found, whereas the area to the south of the 1974 trench is characterised by numerous hearths, in combination with flint, stone, bone and pottery. A small cluster of flint was also located on the bank of the creek. However, separate special activity zones could not be attested with the stone or flint artefacts and tools.

27 The excavation trench was divided into 10 long strips of 0.5 m wide, of which the soil from strips 8 and 9 was integrally sieved over 2 mm meshes while strips 0 to 7 were excavated by shovelling (see section 2.7.4).

Table 5.35 Artefact percentages at the levee sites.

	S2		S3		S4		S41 *		S51	
	Number	*% ≥ 1 cm*	*Number*	*% ≥ 1 cm*	*Number*	*% ≥ 1 cm*	*Number*	*% ≥ 1 cm*	*Number*	*% ≥ 1 cm*
Debitage material	**505**	49.2%	**11147**	68.9%	**918**	61.9%	**31**	54.4%	**83**	54.6%
Flakes	107		3824		295		12		22	
Flake fragments	194		4362		363		7		35	
Blades	17		1061		88		5		5	
Blade fragments	164		1522		132		4		18	
Rejuvenation pieces	10		211		20					
Cores	13		167		20		3		3	
Tools	**198**	19.3%	**1420**	8.8%	**163**	11.0%	**4**	7.0%	**27**	17.8%
Scrapers	28		435		49		2		13	
Borers	12		27		3		1			
Rounded pieces	9		41		10					
Trapezes	7		40		6				2	
Transverse arrowheads	1		6							
Tools on flake	23		205		14				2	
Tools on blade	59		209		24		1		5	
Tools on other blanks	7		53		5					
Indet. tools	4		14		5				1	
Indet. tool fragments	38		247		44				2	
Retouched chips	10		143		3				2	
Bipolar pieces	**26**	2.5%	**721**	4.5%	**52**	3.5%	**2**	3.5%	**3**	2.0%
Visible use-wear	**65**	6.3%	**468**	2.9%	**78**	5.3%	**1**	1.8%	**12**	7.9%
Polished axe fragments			**38**	0.2%	**2**	0.1%				
Other tools			**2**	0.0%	**1**	0.1%				
Waste	233	22.7%	2375	14.7%	270	18.2%	19	33.3%	27	17.8%
Indet. fragments	78		713		101		7		10	
Frost flakes	28		392		30		3		2	
Potlids	110		1162		133		5		14	
Nodule	17		108		6		4		1	
Subtotal ≥ 1 cm	***1027***	*100%*	***16171***	*100%*	***1484***	*100%*	***57***	*100%*	***152***	*100%*
	74%		64%		40%		97%		70%	
< 1 cm	**359**		**9194**		**2218**		**2**		**65**	
	26%		36%		60%		3%		30%	
Total	**1386**		**25365**		**3702**		**59**		**217**	

* No excavations were conducted at site S41, only ditch slope inspections.

As a concluding remark Geuverink states that site S4 shows more similarities in its use of space with site S3 than with site S2. In terms of features and spatial patterning the similarities are striking, while site S2 stands out because of its cemetery and its limited number of postholes.

A remarkable feature is the group of similar blades recovered in one find spot. The set of seven blades found together in the same quarter of a square metre in working pit 2 indicates their close relationship. Their similar lengths and technological features reinforce this statement, as the sequential refit of two of the blades does. One might suggest that these blades form a special group as they stand out technologically from the remaining debitage material at the site. It appears these might also be produced by the specialised blade technique seen on sites S2 and S3 (see section 5.5.5). Whether this set forms some sort of deposit like on the Hoge Vaart site (Peeters et al. 2001: 57-59), is the reflection of a small special activity site or is an accidental grouping of imported blades is uncertain. No specific find circumstances that could shed some light on this issue were recorded during excavation.

Table 5.36 Artefact percentages at the river dune sites.

	S21-S24 * Number % ≥ 1 cm		S61 Number % ≥ 1 cm		S80-S84 Number % ≥ 1 cm	
Debitage material	**3207**	60.8%	**621**	78.2%	**108**	63.2%
Flakes	1761		311		48	
Flake fragments			133		13	
Blades	1163		47		16	
Blade fragments			73		7	
Rejuvenation pieces	101		20		7	
Cores	182		37		17	
Tools	**916**	17.4%	**20**	2.5%	**18**	10.5%
Scrapers	29				5	
Borers	4					
Combination tool	1					
Rounded pieces	4		1			
Microliths	94		1		2	
Trapezes	1					
Transverse arrowheads						
Tools on flake	22		2		2	
Tools on blade	17		1		3	
Tools on other blanks	5		2		3	
Unspecified tools	728					
Indet. tool fragments	8		3		2	
Retouched chips	3		10		1	
Bipolar pieces	**32**	0.6%	**1**	0.1%		
Visible use-wear	**71**	1.3%	**4**	0.5%	**1**	0.6%
Polished axe fragments	**1**	0.0%				
Other tools	**1**	0.0%				
Waste	**1047**	19.8%	**148**	18.6%	**44**	25.7%
Indet. fragments	421		73		16	
Frost flakes	130		47		13	
Potlids	474		27		10	
Nodule	22		1		5	
Subtotal ≥ 1 cm	***5275***	*100%*	***794***	*100%*	***171***	*100%*
	73%		43%		73%	
< 1 cm	**1933**		**1043**		**62**	
	27%		57%		27%	
Total	**7208**		**1837**		**233**	

* These do not include the material from 1971-1973 and finds bags A-K.

5.6.5 Site S51

As the spatial information on the artefacts from site S51 was also lost over time, we can currently only rely on the analysis by Deckers (1979). On site S51 he could define two horizontal concentrations of flint. On the field drawing, which only depicts the 79 hand collected artefacts, I could only establish one concentration. It is unclear what concentrations Deckers refers to as the specific drawing seems to be missing in the publication. Yet when the percentages are depicted, the presence of the single concentration is confirmed.

5.6.6 Site S61

The spatial information of site S61 is very limited. It can be found in de Roever (2004) (see section 2.6.15) and is restricted to the vertical distribution. It regards the presentation of the different layers found at the site. The only flint artefacts for which this information is still available

Table 5.37 Detailed artefact percentages of debitage material and tools at the levee sites.

	S2		S3		S4		S41 *		S51	
	Number	*% ≥ 1 cm*	*Number*	*% ≥ 1 cm*	*Number*	*% ≥ 1 cm*	*Number*	*% ≥ 1 cm*	*Number*	*% ≥ 1 cm*
Debitage material	**505**	100%	**11147**	100%	**918**	100%	**31**	100%	**83**	100%
Flakes	107	21%	3824	34%	295	32%	12	39%	22	27%
Flake fragments	194	38%	4362	39%	363	40%	7	23%	35	42%
Blades	17	3%	1061	10%	88	10%	5	16%	5	6%
Blade fragments	164	32%	1522	14%	132	14%	4	13%	18	22%
Rejuvenation pieces	10	2%	211	2%	20	2%				
Cores	13	3%	167	1%	20	2%	3	10%	3	4%
Flake / blade ratio	1.7		3.2		3.0		2.1		2.5	
Flake / blade ratio **	4.3		4.6		4.7		2.1		5.7	
Tools	**198**	100%	**1420**	100%	**163**	100%	**4**	100%	**27**	100%
Scrapers	28	14%	435	31%	49	30%	2	50%	13	48%
Borers	12	6%	27	2%	3	2%	1	25%		
Rounded pieces	9	5%	41	3%	10	6%				
Trapezes	7	4%	40	3%	6	4%			2	7%
Transverse arrowheads	1	1%	6	0%						
Tools on flake	23	12%	205	14%	14	9%			2	7%
Tools on blade	59	30%	209	15%	24	15%	1	25%	5	19%
Tools on other blanks	7	4%	53	4%	5	3%				
Indet. tools	4	2%	247	17%	5	3%			1	4%
Indet. tool fragments	38	19%	143	10%	44	27%			2	7%
Retouched chips	10	5%	14	1%	3	2%			2	7%

* No excavations were conducted at site S41, only ditch slope inspections.
** Without regular blades.

are part of the sieved material. This is, however, just 5% of the flint artefacts.

Both de Roever (2004: 29) and Deckers et al. (1980: 142) concluded that layers A to C are Mesolithic and that layers K and L are later, and possibly may even be Neolithic. Most of the flint fragments in this restricted spatial analysis are found in layers A and B. If we believe this little sample to be representative of the whole assemblage at the site, this would suggest that the flint material is of Mesolithic date, whereas the stone material, mostly found in layers K and L, is of Neolithic date (see section 4.7.3).

5.7 Synthesis and conclusions: comparison and interpretation of the flint artefacts

5.7.1 Artefact percentages on all sites

The flint artefacts discussed in this study are gathered from ten different sites from two geomorphological different settings, the levee sites and the river dune sites. The material is not only partitioned by site, and in this section discussed by archaeological context, but also by size class, artefact group and artefact type. The numerical presence of these artefact groups is different for each site as each assemblage is characterised by different proportions.

The primary division of the flint material in this study is the separation based on length measured along the debitage axis (see section 3.1.2). Although the proportions of artefacts < 1 cm and artefacts ≥ 1 cm may be the result of the excavation technique, whether systematic sieving of all soil was applied or not, the intrinsic character of the site is also important.

The excavation technique for the five levee sites under discussion was basically the same, with the exception of site S41. The technique entailed gathering the larger artefacts by hand and sieving of all the removed soil to recuperate the smaller artefacts. However, this method was not applied as thoroughly on each site. The soil of the recent excavations at site S4 (campaigns 2005, 2006 and 2007) was not integrally sieved, only two rows out of ten (c. 1/5 of the soil), as it was considered too time consuming. At site S51 only 3 litre probes of every square metre were

Table 5.38 Detailed artefact percentages of debitage material and tools at the river dune sites.

	S21-S24		S61		S80-S84	
	Number	*% ≥ 1 cm*	*Number*	*% ≥ 1 cm*	*Number*	*% ≥ 1 cm*
Debitage material	**3207**	100%	**623**	100%	**108**	100%
Flakes	1761	55%	311	50%	48	44%
Flake fragments			133	21%	13	12%
Blades	1163	36%	47	8%	16	15%
Blade fragments			73	12%	7	6%
Rejuvenation pieces	101	3%	20	3%	7	6%
Cores	182	6%	39	6%	17	16%
Blade: flake ratio	1.5		3.7		2.7	
Flake / blade ratio *	-		4.9		2.9	
Tools	**916**	100%	**19**	100%	**18**	100%
Scrapers	29	3%			5	28%
Borers	4	0%				
Combination tool	1	0%				
Rounded pieces	4	0%				
Microliths	94	10%	1	5%	2	11%
Trapezes	1	0%				
Transverse arrowheads						
Tools on flake	22	2%	2	11%	4	22%
Tools on blade	17	2%	1	5%	3	17%
Tools on other blanks	5		2	11%	1	6%
Unspecified tools	728	79%				
Indet. tool fragments	5	1%	3	16%	2	11%
Retouched chips	3	0%	10	53%	1	6%

* Without regular blades.

sieved. And the question remains how efficient the use of a cement mixer was to loosen the soil before it was sieved at the old excavations of sites S2 and S3. The few artefacts at site S41 are the result of at least one ditch slope inspection, exclusively gathered by hand; these are therefore hard to compared to the other levee sites. In the following comparison site S41 will often be regarded separately.

The proportion of artefacts < 1 cm to artefacts ≥ 1 cm is roughly 30% versus 70% (see tables 5.35 and 5.36). On site S2 this is a bit lower, on site S3 a bit higher. For site S4, these percentages are nearly reversed; the artefacts < 1 cm reach as high as 60% while the artefacts ≥ 1 cm reach only 40%. This means that twice as many chips were retrieved from a site where only 1/5 of the soil was sieved. This reversed proportion is also attested for site S61. The low number of artefacts < 1 cm at site S41 is the result of the hand colleting of the material from the ditch slopes.

Regardless of the proportions of the different artefact categories, the debitage material always represents the largest number of artefacts ≥ 1 cm per site, followed by the waste material and the tools. The four other artefact categories occur rarely.

For the levee sites, it may be observed that the low amount of debitage material on site S2 is combined with a high number of tools (table 5.35), whereas the high amount of debitage material for site S3 is accompanied by a low percentage of tools. The amount of debitage material and tools on sites S4 and S51 falls in between those of sites S2 and S3, with site S51 leaning towards S2 and site S4 leaning towards S3. The same applies to the bipolar pieces and the artefacts with visible use-wear traces, even if the numbers are low. Additionally, polished flint axe fragments only occur on sites S3 and S4. The waste material is the only artefact category not keeping to the dichotomy between sites S2 and S51 on one hand and S3 and S4 on the other.

The amount of debitage material at the river dune sites is roughly equal to that of sites S3 and S4; site S61 clearly peaks (table 5.36). The percentages of the tools are even more erratic; trenches S21-S24 show an exceptional high number of tools whereas site S61 has a very low number, well below that of site S3. Sites S80-S82 are in correspondence for the debitage material and the amount of tools, but show a large quantity of waste. Both bipolar pieces and polished axe fragments are nearly exclusively retrieved from trenches S21-S24.

When the debitage material is analysed in detail, it is clear that the debitage is focussed on the production of flakes (table 5.37). The amount of flakes versus blades is the lowest on site S2 (1.7:1) and the highest on site S3 (3.2:1). Again, site S4 (3.0:1) and site S51 (2.5:1) are situated in the middle. Yet, S51 leans more towards the cluster of sites S3 and S4 than to site S2. The amount of rejuvenation pieces and cores is on all sites equally low, between 3% and 5%. Most remarkable is the total absence of rejuvenation pieces on sites S51 and S41.

For the river dune sites the dominance of flakes is even greater, from 2.7:1 on sites S80-S84 to 3.7:1 at site S61 (table 5.38). Again, site S61 is at the opposite extreme of site S3. The number of rejuvenation pieces and cores is also larger than on the levee sites ranging from 8% to 22%.

The tool composition is less easy to compare by the larger tool type variation and the smaller percentages. Yet, it may be observed that the amount of scrapers is equal for sites S3 and S4 whereas site S51 shows a larger amount. The low number of scrapers on site S2 is compensated by the highest number of retouched pieces, especially the retouched blades. Sites S3 and S4 both show larger proportions of indeterminate tools and fragments thereof, although the fragmentation rate is different for both sites. All other tool types are present, in small amounts, on sites S2, S3 and S4, only site S51 is characterised by a smaller set.

The tool composition for the river dune sites is even harder to compare as large amounts of tools from trenches S21-S24 have not been identified by sub-type, and the amounts at site S61 and sites S80-S84 is generally low. The presence of microliths is one of the most obvious differences with the levee sites. Scrapers and retouched pieces are also present on all river dune sites. The largest variety of tool types may be observed at trenches S21-S24.

As said above, polished flint axe fragments only occur on levee sites S3 and S4, but also in trenches S21-S24. Another Neolithic feature visible at the four trenches is bipolar pieces. The few 'other' artefacts are so rare and of such a specific nature that they are not analysed at this level. For details on these finds, please see the artefact descriptions per site in catalogue chapter 2.

In conclusion, it may be clear that site S51, proportion wise, resembles site S2 the most, also in chips versus larger artefacts. The high percentage of tools and the low number of debitage material give the sites the appearance of special activity sites, focussed on retouched blades for site S2 and on scrapers and retouched blades for site S51. Site S4 is most often similar to site S3. With high numbers of debitage material and a low tool count these two sites may be seen as residential sites. Also in tool composition sites S3 and S4 are very similar. One exception that sets site S4 aside from the others is the high number of chips. The artefacts with visible use-wear traces may not be defined as "modified tools" strictly speaking but are clearly used. Their presence is lowest on site S3, which is in conformity with the low tool count of the site, and the highest with S51 linking these blades to the dominant group of retouched blades.

For the river dune sites this equation is less clear. The debitage material from trenches S21-S24 and sites S80-S84 is similar to that from site S4. The high number of tools of trenches S21-S24 corresponds to sites S2 and S51, yet is not mirrored by a low number of debitage. The percentage of tools at sites S80-S82 corresponds best with site S4. Site S61 is, with the very high debitage count and very low number of tools, at the opposite extreme of sites S3 and S4. It is also very different from the others with its dominance of artefacts < 1 cm, a characteristic it only shares with levee site S4. Trenches S21-S24 set themselves apart from the other river dune sites by the presence of bipolar pieces and polished flint axe fragments, which they have in common with the levee sites.

Waste material is most frequent on site S2; at site S3 this is the lowest. Again, sites S4 and S51 are located in between. It appears that the high number of waste and the low number of debitage at site S2 is mirrored by S3, with high numbers of debitage and low numbers of waste. However, one would expect site S3 to have a larger amount of waste because of the domestic character of the site. For the river dune sites the amount of waste is of an intermediate amount, except for sites S80-S82. The high percentage of waste at these sites is not mirrored by the debitage material as on site S2. Therefore, the high number of waste and the low number of debitage at site S2 might be an isolated event.

5.7.2 Debitage material and the use of raw material

As said above, the debitage material at all sites is dominated by flakes. Yet the proportion between the flakes and the blades fluctuates per site. The dominance of flakes is greater for the river dune sites, just as is the amount of rejuvenation pieces and cores. This might suggest a more pronounced flake production at the river dune sites, or simply the absence of the import of regular blades (see below). After all, the few blade cores were found on the river dune sites.

The flakes are predominantly or exclusively detached in a unidirectional manner. On sites S2, S3 and S4 between

Table 5.39 Percentages of blades and regular blades per site.

	S2		S3		S4		S51	
Blades unidirectional	174	96%	2337	90%	200	91%	23	100%
Blades bipolar	7	4%	246	10%	20	9%		
Total blades	**181**	**100%**	**2583**	**100%**	**220**	**100%**	**23**	**100%**
Regular blades	111	64%	797	34%	86	43%	13	57%
Blades less systematically	63	36%	1540	66%	114	57%	10	43%
Blades unidirectional	**174**	**100%**	**2337**	**100%**	**200**	**100%**	**23**	**100%**

	S21-S24		S61		S80-S84	
Blades unidirectional	618	99.8%	120	100%	23	100%
Blades bipolar	1	0.2%				
Total blades	**619**	**100%**	**120**	**100%**	**23**	**100%**
Regular blades	37	6%	30	25%	1	4%
Blades less systematically	581	94%	90	75%	22	96%
Blades unidirectional	**618**	**100%**	**120**	**100%**	**23**	**100%**

5% and 8% were detached using the bipolar technique, but none on site S51. On the river dune sites the bipolar technique is rarely observed. This is in concordance with the amount of bipolar pieces found: most on sites S3 and S4, almost none on the river dunes.

The flakes are most often broken on the levee sites and more often complete on the river dune sites. Even more, sites S2 and S51 show slightly elevated numbers of broken flakes compared to sites S3 and S4. A discrepancy with the frequency of natural surface coverage could also be observed. The flakes on the river dune sites S61 and S80-S84 more often have remnants of cortex or patina (65% - 68%) than the levee sites (50% - 58%). The exception is site S2 with 72% while trenches S21-S24 resemble the other levee sites. This implies more debitage from the first stages onwards on the river dune sites and site S2, or smaller cores. On average, the fact that there are more decortication flakes on the levee sites, in comparison to the river dune sites, would suggest the latter. The amount of coverage fluctuates per site, with coverage of 1% - 25% occurring most often. It may also be observed that intact flakes more often have remnants of cortex or patina than the fragmented flakes, a feature also discernible for the blades.

The intact flakes have comparable measurements and weights on all sites. Their average measurements range between 15x14x3 mm and 19x18x5 mm while their average weights fluctuate between 1.16 g and 1.58 g. Trenches S21-S24 form the exception with an average weight of 0.97 g, possibly the result of thin flakes. Both sites S41 and sites S80-S84 have rather large and heavy flakes which may be the result of the hand collecting and limited number of the artefacts.

The blades are also primarily detached using the unidirectional debitage technique. Bipolar technique occurs in small numbers on sites S2, S3 and S4 (4% - 10%), and is absent at levee site S51. On the river dune sites bipolar blades have only been observed in very small amounts in trenches S21-S24.

On the levee sites a large percentage of the unidirectionally detached blades are of the regular type with parallel edges and ridges (table 5.39). This is particularly so for sites S2 and S51 (64% - 57%). For sites S3 and S4 the majority of the blades are produced less systematically and have an 'irregular appearance' (see section 3.1.2), a feature also observed at the river dune sites, although the amount of regular blades at the levees may not be underestimated (797 and 86 respectively). Such large amounts of regular blades clearly points to a separate production and supply and not to occasional artefacts being picked up from other sites. The blades are most often broken (59% - 91%), especially for site S2. Only on sites S80-S84 are the blades more often intact. The nature of fragmentation is strongly diverse on the different sites. Sites S2, S3 and S4 have a dominance of medial parts, which are less often found, or

Table 5.40 Average measurements of intact blades and regular blades per site.

	Intact regular blades			Intact blades less systematically		
	L	W	T	L	W	T
S2	44	16	4	23	10	4
S3	36	13	4	20	8	4
S4	43	15	4	23	9	4
S21-S24	20	7	1	19	8	3

even absent, on all other sites. The latter are characterised by proximal-medial or medial-distal parts.

The presence of natural surface on the intact blades is similar to that on the intact flakes. Generally less cortex and patina is present on the blades from the levee sites than on those from the river dune sites. Again, trenches S21-S24 are not in concordance with the other river dune sites. The high percentage of natural surface on the intact blades for site S51 may be the result of their low number. The fragmented blades on the site do not show this discrepancy. Decortication blades, occurring far less than the decortication flakes, are present on all river dune sites and on levee sites S3 and S4, yet absent at S2 and S51.

The intact blades show more dimensional variation than the flakes. The average dimensions range from 20x8x3 mm to 33x13x5 mm. Sites S2 and S4 are comparable, whereas site S3 has smaller and lighter blades. This is in agreement with the low number of regular blades at that site. The few intact blades on site S51 are especially large and thick. When the average measurements of the intact regular blades are set against those of the less systematically produced blades this dimensional variation may be explained (table 5.40). It appears the regular blades are generally longer[28]. Another aspect is the average thickness of the regular blades which differs between the levee sites and the river dunes sites. Partly, the size of the sample will have influence on the matter, yet, the difference between 1 and 4 mm is possibly substantial enough to point out a distinction between both sets of blades. However, whether this is a reflection of a different selection of blades, i.e. the preference of thin or thick blades, or whether this points to a difference between a Mesolithic production technique and a Neolithic production technique, and thus a different age of the blades, is currently unclear. Further research is needed to confirm any of these hypotheses.

The preference for blades as tool blanks and tool types has already been observed at this site. The blades on the river dunes are generally smaller and lighter. The exception is formed by sites S80-S84 where, because of the low number of blades on these sites, one large regular blade is able to make the average measurements peak (see section 5.7.4). This blade clearly is larger and wider than most blades at the sites.

The rejuvenation pieces are on all sites, where they are present, dominated by the striking edge rejuvenation pieces. Platform rejuvenation pieces, core tablets and production plane rejuvenation pieces occur far less. On all sites, most of the rejuvenation pieces are still covered with some sort of cortex or patina. Their average dimensions are largely comparable at around 21x13x6 mm. At site S4 they are just a bit smaller, at site S2 just a bit larger. It was observed that blade-rejuvenation combinations occur on nearly all sites.

On all sites, the type of core appearing the most is the tested core. The cores with one striking platform and two striking platforms, opposing or transverse, occur somewhat less, while cores with multiple striking platforms are the rarest. Most cores show no sign of systematic debitage, well prepared platforms or maintained production planes. The striking platforms are often plain or consist of natural surfaces. Two or three, to a handful of detachments is often the yield of one core. These tested cores are possibly even more ad hoc than the other cores. On all cores from the levee sites (irregular) flake scars often occur while blade scars seldom appear. If blade scars occur, they are always joined by flake scars and may be considered as 'blade-like flakes' (see section 3.1.2). On the river dune sites more blade cores occur, some even quite regular, yet all are rather small. The debitage seems to be more controlled on the river dune sites with somewhat better preparation and more removals per platform.

Generally all cores are rather small with average measurements between 24x19x11 mm and 31x27x20 mm. Combined with the fact that nearly all cores have smaller or larger remnants of natural surface this suggests the limited exploitation of the cores before they were abandoned.

The percentage of chips on the sites is generally around 30%; on sites S4 and S61 this is c. 60%. This is not the only discrepancy found. The chips at sites S2 and S3 are very alike, with average weights at 0.14 g and 0.13 g. Their percentage of possible microchips, weighing between 0.01 g

28 Not all sites could be integrated in table 5.40 as not all sites have intact regular blades.

and 0.05 g, is 26%. Site S4 shows similarities to the river dune sites. The average weight of the chips is less (0.08 g – 0.11 g), more microchips occur (41% - 56%), and the dominant weight classes are 0.01 g and 0.03 g, instead of 0.05 g for sites S2 and S3. Site S51 is rather hard to place, although chips of 0.05 g occur the most, the average weight is 0.11 g. Possibly the limited amount of sieved soil is confusing the picture.

By combining all these aspects certain characteristics of the debitage system present themselves. The conclusions will be presented separately for the levee sites and river dune sites.

First of all, the nodules on the levee sites are just sufficient in size to produce the cores. These remaining nodules may even be the smaller residual specimens as the larger sized nodules were presumably used first, and were thus transformed into cores. These cores are generally rather small, up to 30-40 mm, and their number, along with that of the rejuvenation pieces, is low on the levee sites. Judging by the length of the flakes and the decortication flakes, the cores are sufficient in size to produce the flakes at the sites, clustering between 10x6x1 mm and 36x32x13 mm. There might be some doubt for the flakes that reach lengths of c. 50 mm or more. The same applies to the blades. The smaller blades, clustering between 10x4x1 mm and 38x13x8 mm, were most likely produced at the sites, yet the number of large blades reaching up to 50-60 mm is more abundant than for the flakes. These large blades are generally of the regular type with parallel edges and ridges. As none of the cores is sufficient in length, or shows any traces of systematic blade production, it is concluded that these blades were not produced at the sites. The cores at the sites are not even depleted blade cores as most of them still show between 25% and 75% remnants of cortex and/or patina.

For the river dune sites, the picture is different. Flakes and blades, generally smaller and finer than on the levee sites, may all have been produced at the sites, with the exception of a handful of pieces, i.e. a few large regular 'imported' blades that are proof of (limited) use of the river dune sites during the Neolithic. Cores and rejuvenation pieces are sufficient in length and form a larger part of the debitage material than on the levee sites. Debitage itself is more controlled and somewhat more systematic, even several small blade cores occur. However, the number of flakes compared to blades is higher than on the levee sites. This is clearly the result of the imported regular blades, which rarely occur at the river dune sites. When these regular blades are taken out of the equation, the flake / blade ratio of the levee sites rises to 4.3:1 and even 5.7:1 whereas this is 2.9:1 and 3.5:1 for the river dune sites; only site S61 shows a ratio of 4.9:1 when the regular blades are excluded. Thus in this case at the Swifterbant sites, the dominance of flakes at a site does not necessarily mean the dominance of flake production at the site, i.e. more blades were actually produced at the river dune sites than on the levee sites.

The debitage technique used to detach all these flakes and blades is nearly always the unidirectional technique. Bipolar flakes and blades are most often observed at sites S3 and S4, less often at site S2 and not at site S51. On the river dune sites they are rarely seen. This is in conformity with the spread of bipolar pieces, mostly found on sites S3 and S4, and clearly fewer on sites S2 and S51. Their presence on the river dune sites is negligible (see section 5.7.3).

A final observation regards the chips. The bulk of the chips on river dune sites, and on levee site S4, are smaller than on the levee sites. Small chips occur nearly twice as much which is, on the river dune sites, most likely the result of more and careful core and platform preparation. Yet, this is not the case for site S4 where the cores show the same poor preparation as on the other levee sites. The large amount of chips at sites S4 and S61 therefore remains largely unexplained.

The raw material analysis is useful for the debitage system and preferences as well. It is clear that fine-grained flint was preferred over medium- and coarse-grained flint types. The percentages of these different flint types appear however to fluctuate according to site and artefact category.

In section 5.3.4 it was stated that, even though fine-grained flint dominates over medium- and coarse-grained flint on the river dune sites as on the levee sites, the percentages of medium- and coarse-grained flint were generally lower on the river dune sites than on the levee sites. Even more, the number of burnt artefacts is also lower than on the levee sites.

It was also observed that at the river dune sites the quality of the fine-grained flint with bryozoans is even better than on the levee sites, more precisely a lower number of fossils that are very often of a smaller and thinner kind. Both aspects confirm a selective gathering of good quality material. Whether this suggests that the better quality flint was exhausted by the time of the Neolithic occupation, or that the Neolithic people were less fussy about the quality of their flint is open to debate.

The final observation regards to the raw material type of the regular blades. Based on a visual inspection of the 'regular blades' and the 'irregular blades' no difference in colour or texture could be defined. It would therefore appear that the regular blades are produced from the same type of flint as the irregular blades, only of a bigger size, suggesting similar procurement sites. However, as this distinction is based on recognisability, it is not as reliable as the distinction between, for example, flint and Wommersom quartzite.

5.7.3 Tools, ornaments and functions

The Swifterbant area is by origin an area naturally void of stones or rocks. The composition of the flint types and the condition of the nodules present at the different sites indicate the boulder clay deposits as the main source of raw material. More indications are rolled and weathered types of cortex, even sometimes the typical pseudo-cortex and windblown patina but also frost fissures and Hertzian cones.

Typical southern flint types, such as Rijckholt, Lousberg, or Light-grey Belgian flint are not observed on any of the sites[29]. However, some artefacts have a certain 'southern feel' about them. These are especially more opaque, grey coloured flint types. One of these is the large regular blade present in trench S22.

The last group of artefacts possibly of southern origin is the polished flint axes. None of these can positively be defined as southern flint, for example Valkenburg or Light-grey Belgian flint, yet their cultural association, and thus designation, indicates that they are originally from the south. This is an argument only relevant for flint axes, as proof exists of local, northern copies of stone axes.

The size of the nodules is for the most part rather similar. The nodules found at the levee sites cluster roughly between 10 mm and 50-60 mm (figure 5.57). The exceptions are lengths of 72 mm and 102 mm. For the river dune sites two clusters are visible, between 16 and 40 mm and between 73 and 82 mm (figure 5.58). This large gap may be the result of the limited number of measured nodules.

When this dimensional clustering is compared to that of the tested cores[30] the specimens from the levee sites again roughly cluster between 10 mm and 50-60 mm with two larger specimens of 71 mm and 77 mm (figure 5.59) while the specimens from the river dune sites are essentially smaller roughly ranging from 10 mm to 40 mm (figure 5.60). The cluster at 80 mm, visible with the river dune site nodules, is no longer represented by the tested cores.

When all these measurements and clusters are combined, the majority of the nodules and tested cores measure between 10 mm and 50-60 mm; those from the river dune sites are somewhat smaller, often limited to 40 mm. The presence of a few larger specimens, up to 70-80 mm and even 100 mm, confirm the existence of such large

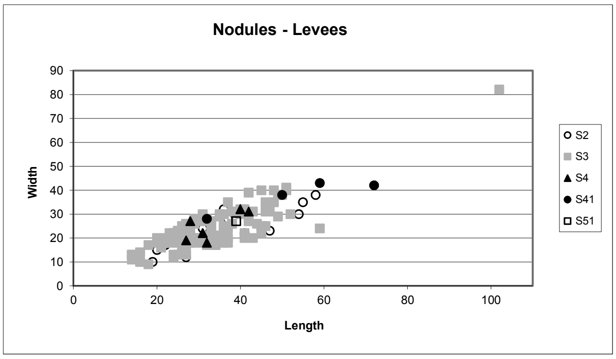

Figure 5.57 Nodules at levee sites.

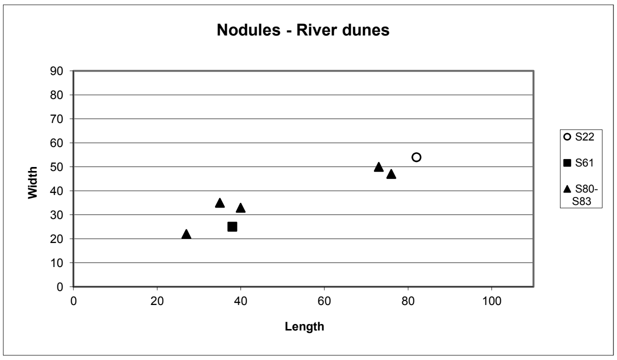

Figure 5.58 Nodules at river dune sites.

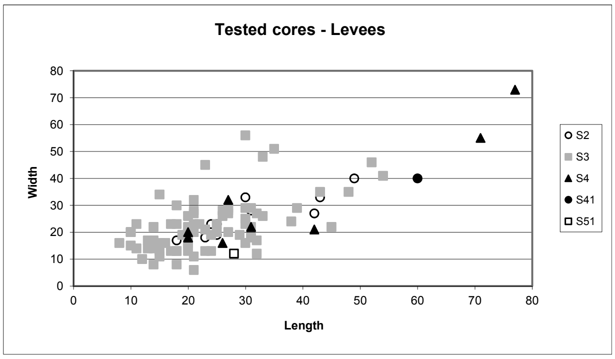

Figure 5.59 Tested cores at levee sites.

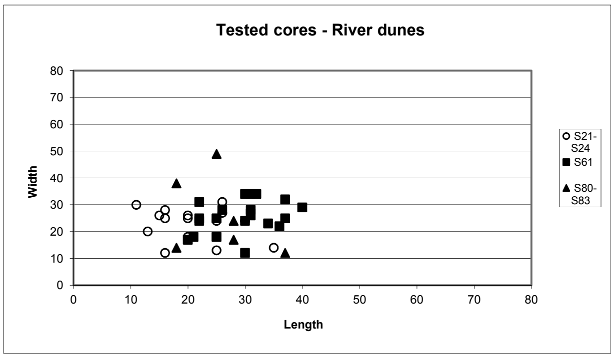

Figure 5.60 Tested cores at river dune sites.

29 As the sample analysed by Raemaekers (1999) could no longer be retrieved (see sections 5.2.2 and 5.2.3), it is impossible to check whether the artefact defined as being made of Rijckholt flint (ibid: 37) is indeed made of that type of flint. Yet, as no other artefact made out of Rijckholt flint was observed at any of the examined sites, it is plausible the definition is erroneous. Possibly it concerns one of the opaque, grey coloured flint types described as having a 'southern feel' about them.

30 These cores only have a few detachments and are therefore rather similar to their original size as nodule.

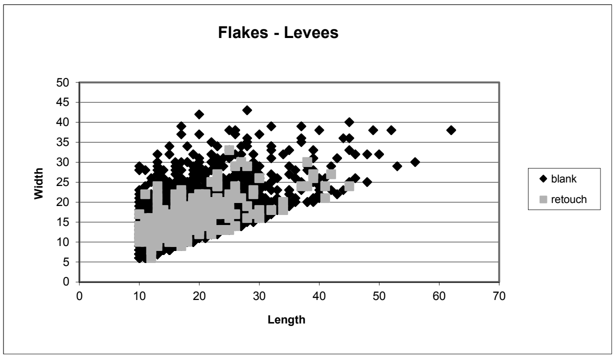

Figure 5.61 Blank flakes and tools on flake at levee sites.

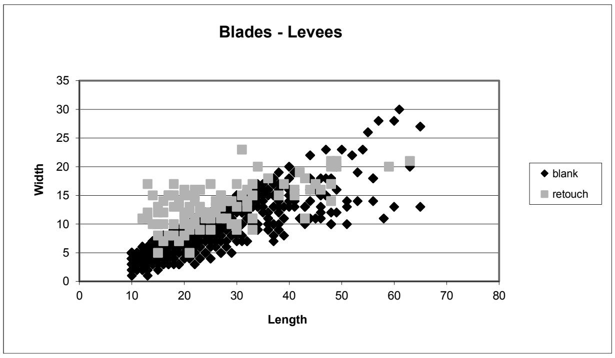

Figure 5.62 Blank blades and tools on blade at levee sites.

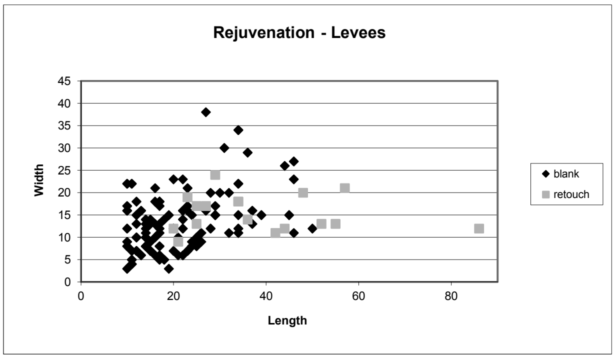

Figure 5.63 Blank rejuvenation pieces and tools on rejuvenation pieces at levee sites.

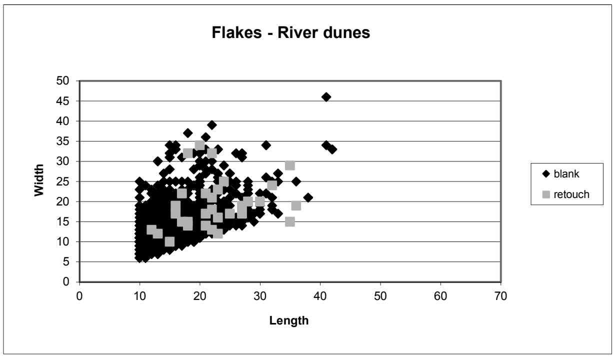

Figure 5.64 Blank flakes and tools on flake at river dune sites.

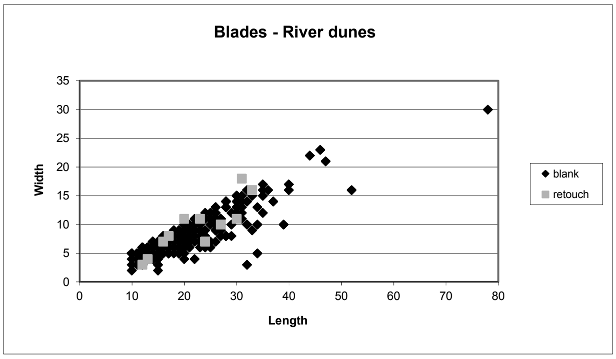

Figure 5.65 Blank blades and tools on blade at river dune sites.

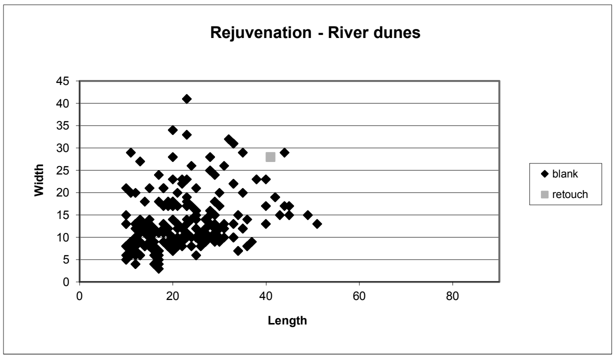

Figure 5.66 Blank rejuvenation pieces and tools on rejuvenation pieces at river dune sites.

nodules and suggest their presence at the procurement sites. Whether this limited representation at the sites also indicates a strain or at least a limitation in numbers at the procurement sites is not at all proven. The large regular blades that are produced 'off-site' or somewhere else (see section 5.7.4) prove the presence of many more of these larger nodules somewhere in the vicinity of Swifterbant.

The graphs also show that the nodules have a rather elongated shape while the tested cores are often wider. When the length-width ratios of both artefact types are considered this appears as well.

A quick scan of the blanks reveals that the flakes at the levee sites measure between 10x6x1 mm and 62x47x27 mm, they cluster between 10x6x1 mm and 36x32x13 mm. For the blades these measurements are 10x1x1 mm and 65x30x25 mm where the blades cluster between 10x4x1 mm and 38x13x8 mm. The tools produced on flakes have a similar dimensional range yet they cluster between 10x10x3 mm and 26x22x8 mm (figure 5.61). Thus, the tools on flakes are somewhat shorter and narrower than the unretouched blanks. For the blades this is the same as the tools cluster between 12x10x2 mm and 34x17x6 mm (figure 5.62). It should be mentioned that the tools on blades with the dimensions of flakes are actually shortened blades. The rejuvenation pieces show a different image. It is clear that the larger specimens were chosen to be used for tools (figure 5.63).

For the river dune sites, this image is somewhat different. In this case all retouched artefacts fall within the limits of the unretouched blanks, even the rejuvenation pieces. Additionally, the retouched artefacts form even less tight clusters as their numbers are more limited compared to the levee sites (figures 5.64 – 5.66).

When the different flint types are regarded separately, the medium- and coarse grained artefacts have generally the same dimensional range as the fine-grained flint artefacts and tools. They are all randomly spread within this range. Only three medium-grained artefacts or tools are wider, not longer, than the limits set by the fine-grained flints.

Scrapers

A total of 550 scrapers was found on the Swifterbant sites. Site S61 is the only site where no scrapers have been retrieved. Scrapers are mainly made from fine-grained flint without bryozoans (65%), and to a lesser extent from fine-grained flint with bryozoans (25%). Medium-grained flint occurs rarely (1%), coarse-grained flint was not used. Heat exposure prohibited the raw type analysis of the remaining 8%. This image is largely the same for all sites.

The scrapers were mainly made on flakes which may create a large morphological variation as seen on site S4. The scrapers on blades have a more regular appearance and are the dominant type on site S2 and site S51. The variety of different blank types is the largest on sites S3 and S4 and the most selective on site S2 as if specific activities were carried out with specific types of tools. The few scrapers found on sites S80-S84 also show a large morphological variety. Yet, technically most scrapers are alike. The dominance of end scrapers, more often single than double, over side and round scrapers is clear on all sites. Scraper fronts are generally located distally and dorsally. The shapes are rectilinear, curved or rounded; oblique or irregular delineations were occasionally observed.

The fragmented scrapers are mostly larger scraper fragments and less often broken off scraper fronts. Here also, distal fronts appear more often than proximal fronts. The dominance of end scrapers is also discernible with the scraper fragments as their general appearance suggests.

The measurements of intact specimens generally fall within 10x10x3 mm and 27x22x10 mm, with a few measuring between 28x23x11 mm and 47x32x15 mm in length. The same pattern is visible for the fragments, just a bit smaller. Additionally, only sites S2 and S3 have intact scrapers longer than 30 mm. Yet, when the average measurements are compared sites S2, S3 and S4 are very similar. The few scrapers on site S51 are smaller.

Some more remarks can be made. It appears that when the scraper front broke off, which must have regularly happened considering the numerous smaller scraper fragments, a new front was fabricated resulting in smaller specimens. Re-sharpening, without prior breakage, must have occurred as well.

Some larger end scrapers from site S2 have gloss on one or two of the edges of the blade. This indicates a prior, a secondary, or an alternate use.

The usability of the miniature versions of the scrapers may be questioned, yet it cannot be ruled out they were used in some sort of composite tool such as is the case with microliths.

Scrapers may be used for a wide variety of activities. The processing of hide and plant material, both in cutting and scraping motions, are the most common. Small specimens may also be used for the scraping or smoothing of fresh pottery. Bone or wood may also be worked with scrapers, yet this is not their most common use.

Borers

A total of 46 borers were counted on levee sites S2, S3, S4, S41 and in trenches S21-S24. They were made most often from fine-grained flint without bryozoans (59%), and less out of fine-grained flint with bryozoans (17%). Up to 24% could not be defined due to heat exposure. Only on sites S2 and S3 were sufficient specimens present for a comparison. On site S2 fewer borers were exposed to heat and the proportion of fine-grained flint without bryozoans was even higher (67%).

Although they are predominantly made from blades, the technological variation is rather large. The borer's tip may have straight, curved, or oblique retouched edges formed by dorsal or ventral retouches, or a combination of both. This tip may be located proximally or distally, with a slight preference for distal on site S3. Rounding-off of the borer tip has been observed in a few occasions on nearly all sites.

Very often the borers were broken impeding dimensional comparison. Still, their dimensions vary considerably; some of the fragments are even larger than the intact specimens. Generally the intact borers measure between 13x8x2 mm and 41x16x6 while a few specimens are larger measuring between 45x17x7 mm and 49x22x12 mm. A thickness of 18 mm was only recorded once.

Their function is rather straight forward, yet the contact material may be varied. The perforation of organic materials such as hide, bone or possibly even plant material such as wood may be suspected, as well as inorganic materials such as stone or pottery.

Rounded pieces

The rounded pieces, more often showing one rounded end than two, are made from a variety of blanks. Their raw material is also rather varied. Fine-grained flint without bryozoans was used half of the time (55%), whereas fine-grained flint with bryozoans was used somewhat less. Medium- and coarse-grained flint was used quite often (5% and 3%), especially when compared to other tool types. The remaining 8% could not be identified due to heat damage by overheating.

The used blanks are mainly blades, yet the variety of other blanks is rather large. The location of the rounding seems to be related to the overall shape of the blanks. The rounding of artefacts with a triangular cross section is visible on the edges as well as on the dorsal ridge. The rounding-off is the strongest at the largest diameter of the tip suggesting the tool is used as a borer or in some sort of drilling or perforating activity. The rounding on artefacts with a flatter appearance covers mainly the (lateral) edges suggesting they might have been used in some sort of scraping motion. It is not unthinkable that the different shape of the blank may have led to the selection for a different activity.

The tools are more often broken than intact, even small broken off tips have been recovered. Therefore, measurements of the broken specimens range from as small as 4x4x2 mm well up to 71x30x20 mm. The intact specimens generally measure between 16x7x2 mm and 33x20x7 mm, whereas lengths of 39 mm and 86 mm occur only once. Thicknesses above 8 mm are rare as well.

Two specimens are exceptional because of their rare shape. The first is the large crested blade with rounded tip found at site S3. It is a curiosity and may even be regarded as some sort of trophy or proof of accomplishment or skill. It was clearly brought to the site as none of the cores on any Swifterbant site is large enough to have produced this kind of blade. Even more, the reduction technique, i.e. crested blade, is rarely seen at the sites.

The second is the *briquette* or *bikkel* lookalike. The tool measures 71x30x20 mm and is made from coarse-grained flint. One tip is lightly rounded, at the other end several chips or small flakes have randomly been chipped off.

Furthermore, several other tools show rounding at their tips like scrapers, borers, retouched flakes and blades, indeterminate tools, and a blade from a polished flint axe. This indicates the variety of activities that leads to rounding.

These aspects suggest a relationship between some of the rounded pieces and borers. Similarities are the choice of blanks, mostly blades, and the high fracturing rate. Yet, differences exist as well, for example the choice of flint type. For borers mainly fine-grained flint without bryozoans was chosen, whereas the rounded pieces are nearly as often produced out of fine-grained flint with bryozoans as they are produced out of fine-grained flint without bryozoans, and the percentages of medium- or coarse-grained flint types are also greater. Perhaps the borers and rounded pieces were used for similar activities, making the choice of similar types of blanks an obvious one.

The use-wear analysis of the rounded pieces revealed multiple functions. Traces of hide, mineral substances, and natural wear were observed on the tips and rounded off fractured ends of the artefacts. Several of the rounded pieces, especially the longer specimens, also showed traces of contact with siliceous plants, hide, and wood on the edges. These may point to two simultaneous activities although in some cases the traces revealed a sequential order indicating re-use of the tools. Thus, activities performed with these tools may range from making fire, processing and perforating all kinds of material including hide, bone, antler, wood, or even stone and pottery, to the pulverisation of soft, mineral substances. That the rounding-off is the result of some kind of hafting arrangement is also an option. Undefined rounding and traces on the lateral edges of two artefacts prove that the cause of rounding is even more varied than initially assumed. It seems that this phenomenon of rounding will not let itself be explained that easily.

Microliths

Microliths[31] have been encountered on all river dune sites whereas none have been found on the levee sites. Their number in the analysed sample of trenches S21-S24 is 24 pieces, yet their original number must have been more as at least one finds bag with microliths has gone missing over time. Fine-grained flint without bryozoans was clearly preferred (85%) while fine-grained flint with bryozoans or medium-grained flint is very rare. Heat exposure is also observed very little.

Typologically they are defined as A-, B-, C-, and D-points, together with crescents, triangles and many fragments. These are only the specimens from the analysed sample. Other encountered microlith types are needle and lancette shaped points, double points, backed blades, and triangular backed blades (Price 1981: 89).

Fracturing has regularly been observed. The measurements of the intact specimens in trenches S21-S24 range between 16x3x1 mm and 24x7x2 mm (average 19x5x1 mm). The two intact microliths at sites S80-S84 form extremes of 13x4x1 mm and 24x6x2 mm.

Microliths are used in composite arrowheads. Certain specimens are used as tips, whereas others served as barbs.

31 In this research all microliths are grouped together with the exception of trapezes. The latter are discussed separately to set them apart in order to make a quick and clear distinction between the microlith composition on the river dune sites and the levee sites.

Trapezes
A limited number of 56 trapezes have been found at four levee sites and one river dune site. They are generally made out of fine-grained flint without bryozoans (59%) and less from fine-grained flint with bryozoans (27%). Specimens made of medium- or coarse-grained flint occur only once (2%). At most sites their number is restricted to 7 or less making comparison hardly representative.

Within the group of arrowheads, the asymmetrical trapezes made from blades are the preferred type. They are technologically all very much alike with direct, abrupt, short retouched edges. The overall appearance and morphology of all trapezes varies a bit, yet their average measurements are comparable, between 15x11x2 mm and 18x13x3 mm. Again, sites S2, S3 and S4 correspond best. The same counts for the length-width ratio. Still, the variety is the largest on site S3 which is possibly related to the large amount of trapezes found at that site.

The use of trapezes as arrowheads is likely, hafted on to the arrow's tip. Some of the specimens are lightly damaged suggesting they were used and replaced. The sharp edge of the tools may also have been used to cut or scrape plant material or other substances.

Transverse arrowheads
This type of arrowhead occurs rarely; only seven have been found spread over sites S2 and S3. They are mainly distinct from trapezes by their measurements, i.e. length-width ratio, yet only slightly differ from the trapezes in other respects. They are produced somewhat less systematically and their morphological variation is larger, yet on technological basis they are similar.

Retouched pieces
At all sites the retouched pieces are the largest group of tools. They consist of retouched flakes, retouched blades, and other blanks with retouches and are by definition a very variable group. Whether the retouched flakes outnumber the retouched blades depends on the site. The other types of retouched blanks always take third place. In total 267 retouched flakes, 316 retouched blades, and 74 other blanks with retouches have been found at the different sites. The number of retouched pieces on the river dune sites is rather limited impeding a reliable comparison between the two geomorphological units.

When the retouched pieces are separated by type, the retouched blades outnumber the scrapers only on site S2. On all other sites, the scrapers are the largest group of tools, often twice as common as the retouched flakes or retouched blades. All this is with the exclusion of indeterminate tool fragments which occur very often on all sites.

The retouched flakes are the most numerous on site S3, one of the only sites where retouched flakes outnumber the retouched blades. Retouched flakes are generally made from fine-grained flint without bryozoans (60.3%) and fine-grained flint with bryozoans (29.5%). Medium- and coarse-grained flint occurs in small amounts (2.6% and 0.4% respectively). Sites S2, S3, and S4 are again very similar with elevated percentages (63%) for fine-grained flint without bryozoans. The low percentage of fine-grained flint without bryozoans, in combination with a higher level of fine-grained flint with bryozoans, for the river dune sites is mainly the result of the sample from trenches S21-S24.

The retouches on the edges of these tools generally follow the natural convex, rectilinear or concave curvatures of the blank. Sometimes an existing fracture may be used as well. Denticulated or notched edges occur only now and again. Typical retouches are short, abrupt or semi-abrupt. On site S3 marginal retouches are observed as well, just as irregular shaped edges and truncations. It was observed that the size of the retouches often appears to be related to the general size of the blank, therefore larger abrupt or semi-abrupt retouches occur less often as retouched flakes are generally rather small. The retouches are mostly produced on the dorsal face and often distally. Interestingly enough when ventral retouches appear, this is often in relation with a convex ventral face, as if the choice to retouch either the ventral or the distal face is related to the overall shape of the blank.

Slightly more tools are intact than broken. The dimensions of the intact retouched flakes are very diverse. The largest average measurements are attested at sites S2 and S3, with the large dimension on sites S80-S84 as the result of one large specimen. The smallest are found on site S3. Again, the small specimen found on site S51 makes the average dimensions for that site rather low as well. The retouched flakes cluster between 10x10x2 mm and 30x25x10 mm, dimensions between 34x26x11 mm and 45x35x16 mm occur far less.

The retouched blades are predominant on sites S2 and S51, where they clearly outnumber the retouched flakes. Their number is also high at site S4. These tools were mainly made of fine-grained flint without bryozoans (58.5%) and to a lesser extent of fine-grained flint with bryozoans (21.8%). Medium- and coarse-grained flint were used only a few times (3.2% and 0.6% correspondingly). The percentages of fine-grained flint are lower than for the retouched flakes which might be the result of more frequent heat exposure. A few more specimens were made out of medium- and coarse-grained flint. These percentages fluctuate for the different sites. A high number of medium-grained flint and frequent heat exposure at site S2 may be observed, a tendency also seen at trenches S21-S24. At site S4 specimens made of fine-grained flint without bryozoans are rather high in number while fine-grained flint with bryozoans drops to an exceptionally low level. The general distribution reflects the percentages on site S3 the best as these represent the bulk of the retouched blades.

The retouched blades are predominantly backed blades, thus without the retouches altering the general shape of the straight edged blades, with far less denticulated, notched or truncated blades. For the most part regular blades were used with two parallel edges and ridges. The retouch is located on one or two edges, mostly on the dorsal face, less often on the ventral face. Combinations of one edge dorsally and the other ventrally retouched or even alternate retouch on one or both edges occurs as well, especially on site S3. The wider variety at this site is most likely the result of the many retouched blades found there. For example, a feature only observed at site S3 is the additional retouch on the proximal or distal end of the blade making them transitional forms between retouched blades and scrapers. Additionally, use-wear traces such as gloss and use-retouch were noticed on the larger blades and blade fragments at most sites indicating a prior, secondary, or alternate usage of the blades.

Most of the retouched blades are broken, sometimes even a very large percentage as on site S2. On this site, and on site S4, the medial parts are the most numerous, as seen with the unaltered blades. On sites S3 and S51 proximal-medial parts are the most common in favour of the medial parts. On all sites medial-distal parts are observed the least. The intact retouched blades have their largest average measurements at site S2 and S51; sites S3 and S4 are very alike when average measurements are concerned. The intact retouched blades generally measure between 12x5x1 mm and 49x21x10 mm, lengths up to 59 mm and 63 mm are exceptional. The damaged blades range from 10x7x2 mm to 47x23x11 mm, but also have lengths up to 50 mm and 58 mm, filling the gap between c. 50 and 60 mm. When fragments can reach dimensions up to 58x23x5 mm it is likely they were originally longer than the longest intact blade (63x21x7 mm). It has already been observed that the retouched blades are generally larger than the unretouched blades, suggesting the selection of the larger specimens for tool production, except on site S4. On sites S2 and S3 they are smaller than the blades with visible use-wear traces whereas on sites S4 and S51 they are of comparable size.

The remaining retouched pieces are produced on a variety of blanks. These are 16 striking edge rejuvenation pieces, 14 indeterminate fragments, 18 frost flakes, 3 nodules, 10 cores, and 13 bipolar pieces. The main type of raw material is fine-grained flint without bryozoans (62%), while fine-grained flint with bryozoans is used less (19%). Medium-grained flint was used only once (2%). Up to 18% of the tools could not be analysed due to heat damage. These percentages are hard to compare per site as the amounts are generally low. The higher percentage of fine-grained flint with bryozoans (c. 30%) may very well be the result of these low numbers as it occurs on all sites except site S3.

These tools have short and undeveloped retouch that does not alter the general shape of the edges. In contrast to the retouched flakes and blades these occur both equally dorsally and/or ventrally. The blanks used for these tools generally have dimensions comparable to the unretouched blanks, yet it appears the larger specimens were sometimes preferred. Only some of the striking edge rejuvenation pieces are longer than the unretouched counterparts suggesting the larger size was the reason for their selection.

As with the scrapers, retouched tools may have been used for a wide variety of activities. Cutting, pealing, or scraping of plant material are some of the many possible tasks performed. The processing of hide, wood, bone, and antler are all likely as well. Even the cutting of meat or the gutting of fish must have been part of daily activities. It was even observed that use-wear traces such as gloss and use-retouch occur on the larger retouched blades and blade fragments indicating a prior, secondary, or alternate usage of the blades.

Indeterminate tools
This little group of tools consists of artefacts that are of an exceptional type, mostly because they are rare or have an incomparable shape. Their number is limited to 27 and they occur on nearly all sites. As with the other tools they are mainly made of fine-grained flint without bryozoans (63%) and fine-grained flint with bryozoans (19%). One of them is made out of medium-grained flint (4%) while the remaining 15% could not be analysed due to the exposure to heat.

Their shapes and dimensions are very diverse ranging from battered cores or possible hammerstones, to pointed tools or projectile points, and even unfinished products that slightly remind one of certain other tool types. For more details see the specific sections in the catalogue.

Indeterminate tool fragments
The remaining group of the toolkit largely consists of different sizes of tool fragments. These too are generally made of fine-grained flint without bryozoans (54.0%) and fine-grained flint with bryozoans (13.4%) while medium- and coarse-grained flint occurs very rarely (1.2% and 0.3%). However, a larger part than usual is exposed to heat and beyond recognition. This heat exposure is one of the main reasons why the tools are fragmented in the first place.

Although these artefacts are often small fragments that can no longer be positively identified as specific tools, some of them show similarities to certain tool types making them possible fragments of trapezes, truncated blades, borers, or scrapers. Another group is damaged beyond recognition whereas some of them are even smaller fragments, i.e. the retouched chips, which are broken off tips or ends of tools measuring < 1 cm. The smaller fragments may be microlith fragments, especially on the river dune sites, or re-sharpening retouches.

Bipolar pieces
On all levee sites the number of bipolar detachments, whether flakes (714) or blades (275), is limited to 4% to 10% while on the river dune sites they may not even occur. Yet, 809 bipolar pieces have been recovered. These are nearly all from the levee sites as the bipolar detachments might suggest; only four came from the river dune sites. The bipolar pieces are mainly made of fine-grained flint without bryozoans (63.7%) and regularly from fine-grained flint with bryozoans (26.6%). Medium- and coarse-grained flint are used very rarely (0.9 % and 0.6%) while heat damaged pieces are also limited to a bare minimum (8.3%). The bipolar detachments show even more fine-grained flint without bryozoans (70.1%) in favour of fine-grained flint with bryozoans (22.5%) and even less heat damaged specimens (5.4%).

The bipolar pieces are separated into three groups of which the irregular types occur the most. Regular bipolar pieces occur far less while square shaped pieces are the rarest; fragments occur as well. Although their morphology differs their dimensions are very similar. The regular pieces cluster between 14x7x4 mm and 35x26x19 mm, the square shaped pieces between 13x12x4 mm and 32x32x18mm, and the irregular pieces between 10x7x3 mm and 46x39x25 mm. It may be clear that the latter show the largest variety and are generally the only ones exceeding 40 mm in length. These similar dimensions are the result of the use of similar sized blanks.

The analyses revealed that most of the bipolar pieces are still partially covered with cortex or patina. This is a clear indication that their current size is similar to their original size implying the use of small nodules. It was also observed that a limited number of them do not have just one debitage axis but are reoriented a quarter turn to apply a second debitage axis resulting in two crossed axes. As the original striking ridges often show stacked steps and hinges this reorientation must have been an attempt to employ a new striking ridge in an effort to detach more flakes.

In this study one of the characterising features of the bipolar pieces is the lenticular cross section created by the two opposing striking ridges. However, a limited number of the (tested) cores show the application of the bipolar technique. Technically speaking they are tested in a bipolar way meaning that they rested on an anvil when they were struck from above. However, these artefacts do not show two striking ridges but a combination of a striking ridge with a striking platform. It appears to be the intention to reduce the platform by flaking until nothing else but a striking ridge remains. Even though these (tested) cores show signs of bipolar flaking, these are not convincing enough to be defined bipolar pieces. Whether all bipolar pieces are produced in this way is unclear.

Another remarkable aspect is the low number of bipolar detachments in comparison to the number of bipolar pieces. This might indicate that the definition of a bipolar flake or blade should be revised. It appears that several of them might not have been recognised with the current definition as the curvature of the surface of some of the bipolar pieces indicates that not all bipolar flakes need to be flat.

The conducted use-wear analysis suggests that the majority of the numerous bipolar pieces appear to be unused. The opportunistic use of a few of them was demonstrated. Traces on the tip of a regular bipolar piece suggest the artefact was used as 'burin' to engrave a hard material, presumably bone. The traces of plant polish on the edge of a square shaped piece indicate that this artefact was used to process plant material. These traces do not correspond with the presumed function of the bipolar pieces, for example that of wedge or core (see section 3.2.4). However, it cannot be ruled out that the bipolar pieces were used as wedges or cores and that these activities simply did not leave any traces on the pieces themselves. It is not hard to imagine that the use as wedge results in the detachment of very small pieces of the working edge, well before traces are able to develop. One may wonder if the usage of bipolar pieces may ever be proven.

Artefacts with visible use-wear traces
These artefacts are not defined as "modified" tools strictly speaking but they clearly show traces of usage on the edges like gloss and/or use-retouch. As with many tool types a wide variety of blanks may be used. Yet, blades were clearly preferred (77% - 83%) over flakes and other blanks. The use of fine-grained flint without bryozoans (67.1%) and fine-grained flint with bryozoans (21.5%) outnumbers that of medium- and coarse-grained flint (2.7% and 0.2%). Heat damage prevented the raw material type analysis of 8.5% of the tools. As the number of artefacts with visible use-wear traces is very low on the river dune sites, the comparison is restricted to the levee sites. Percentages may vary for up to 10% or 20%. This is possibly under the influence of differences in heat exposure, well attested at site S2; yet, this does not totally justify the higher percentage of fine-grained flint with bryozoans on that site.

The blanks generally fall within the dimensional boundaries set by their unretouched counterparts. Only for the rejuvenation pieces were the largest specimens clearly preferred (c. 50 mm), they are nearly all the longest of their kind. This appears to be related to their exact size as the rejuvenation pieces are generally rather small. The preference for longer specimens is also attested for the blades. The dimensional range is as wide as for the unretouched blades, yet the blades with use-wear traces cluster in length between 30 mm and 60 mm, clearly the longer lengths. The fragments cluster between 20 mm and 45 mm in length but can measure up to 60 mm or even 72 mm. Thus, the blades are first and foremost selected on the basis of their length, and to a lesser degree on raw material type, although the use of fine-grained flint (without bryozoans) is clearly preferred.

These blades are nearly all of the regular type with parallel edges and one or two parallel ridges, even on the river dune sites. As with the retouched blades their fragmentation rate is high (70% - 88%). The distribution of the fragments is, however, different. On sites S2 and S4 the proximal-medial parts are the most common, instead of the medial parts, and on sites S3 and S51 this is the other way round. Even more, medial-distal parts are no longer the smallest group on each site.

Noteworthy is the rounding-off observed on two artefacts with visible use-wear traces at site S4. Exceptional is that the rounding is located on the lateral edge, contrary to the more common tip or fractured end of the artefact, as seen on three specimens from site S3.

The use-wear analysis revealed the frequent use of the blades with visible use-wear traces for processing siliceous plant material. The artefacts did not, however, show any traces of a typical sickle gloss. This does not necessarily mean that the blades were not used to harvest cereal, only that the method by which this was done deviates from the current harvesting experiments conducted.

Most of the tools were used in a scraping motion, whereas a minority was used for cutting the plant material. The combination of both motions was observed on a handful of blades. Traces of hide and antler were also discerned, yet only in small amounts at site S2, whereas evidence shows that some of the artefacts must have been hafted.

The analysis of a handful of blank blades also mainly showed traces of siliceous plant material, both in scraping and cutting motions. Rare traces of hide and mineral substances could also be detected, possibly in combination with bone or antler, suggesting the blades were used for similar activities than the blades with visible use-wear traces, but presumably to a lesser extent, intensity or duration.

Thus, based on the analysis of different sets of blades it appears that a wider variety of activities could be discerned at site S2 compared to sites S4, S51, and S61. The artefacts at site S3 also revealed more than one contact material. However, the presence of 'classic' sickles could not be detected whereas the processing of siliceous plant material was clearly proven. To what extent the transverse oriented polish is related to the processing of plant material for the production of baskets or fibres, or to food processing and food supply, is the topic of on-going experiments. One of the options is that the blades were used in a transverse to oblique manner to pluck, or scrape, the ears from the stems (van Gijn et al. 2007).

Polished flint axe fragments

At none of the sites have fully intact polished flint axes, or even larger parts, been found. All artefacts are small fragments on which only the polished surface gives any indication they were originally part of an axe. Even more, the fragments are not even small bits and pieces of shattered axes but nearly all debitage material. This makes it impossible to reconstruct the original shape of the axe in order to define their type.

Most of the 41 fragments were found at site S3; two more fragments were retrieved from site S4 while one fragment comes from trench S23. Thus, a total absence of fragments at sites S2 and S51 may be observed.

The fragments are mainly flakes, and only very rarely blades or cores. Two of these flakes were even used to make tools, a scraper and a retouched flake. The former is rather small compared to the scrapers made from 'normal' flint blanks, while the retouched flake is much larger than all the other intact retouched flakes.

The different colours and textures of the fragments[32] suggest that at site S3 the fragments may belong to at least three and possibly even up to six different axes, and at site S4 the artefacts are presumably from two different axes. When the pieces of both sites are compared, it appears that the fragments from site S4 are not related to those of site S3. The fragment from S23 largely resembles the grey flint axe fragments from site S3, yet an exact refit was not possible. Thus, fragments of at least five and possibly even eight different axes are present at the sites.

Even though the pieces belong to a limited number of axes, the fragments themselves are not large or numerous enough to form even one complete axe. Also few refits have been found. Therefore, it may be that the artefacts were brought to the site as smaller fragments, i.e. 'imported' as flakes and smaller debitage material. Axes were thus presumably not brought to the site as a supply of raw material (contra Deckers 1982: 35). As only two chips occur, it is not even likely the axes were shattered or reworked into debitage material at the sites themselves and then largely transported away.

Other artefacts

Of the other artefacts, found on sites S3 and S4, the unfinished pendant from site S4 is the most remarkable. It is especially its raw material that sets it aside from all other

32 None of these flint types could positively be identified as a southern flint type such as Valkenburg or Light-grey Belgian flint.

unfinished pendants. Besides quartz, flint is one of the hardest materials, making it almost impossible to perforate with a flint, or other type of borer. As with the few quartz pendants the attempt was quickly abandoned leaving only minor traces on the artefact.

Another very rare artefact is a flint hammerstone. One was found on site S3, the same site where a core was re-used as hammerstone as well.

Functions and activities
The tools present at a site are clear indications of the activities performed at that site. Their numerical presence can even provide information on the frequency by which these activities were performed or on their importance at the site. Generally, certain tool types are indicative of certain activities, and these tools are often produced with that function in mind, like scrapers and hide working often go together. Yet this does not always need to be the case. Tools may be multifunctional, can be re-used in a different way, or may simply be used in a different way than expected. For example, trapezes may be used to process plant material (van Gijn et al. 2001b). The importance of use-wear analysis on this subject has been demonstrated in the past.

The recovered tools are very diverse ranging from scrapers and retouched pieces, to borers and different arrowhead types, or even bipolar and rounded pieces. Most of these tools can be used at a base camp as part of the daily activities or maintenance activities such as gathering and preparing food, processing hides and plant material, or even working with wood, antler or bone. The applications are virtually unlimited.

The large proportion of scrapers and retouched tools at all levee sites imply a high daily activity character of the sites. Sites S3 and S4 are very similar with a dominance of scrapers (30%) over retouched blades (15%). At site S2 this is the other way around. The dominance of retouched blades is, however, also combined with a high percentage of blades with visible use-wear traces. It appears that plant processing activities were more important than possibly hide working, one of the most common activities performed with scrapers. Site S51 is remarkable that it has the highest percentage of scrapers as well as the highest level of blades with visible use-wear traces. This site appears to have specialised in the two specific activities to be performed with scrapers and blades, i.e. hide working and plant processing.

Scrapers are often used to process hides but may also be used for processing plant material. Even the difference between fresh hides and dry hides is of importance to determine the function of the site. For instance, fresh hides may be processed at a hunting camp or hunting stand, while dry hides are most likely processed at a base camp as part of the maintenance activities.

Trapezes are generally interpreted as projectile points, a very likely definition here at the Swifterbant sites as damage as the result of impact was observed.

Microliths have only been recovered at the river dune sites, a characteristic of their Mesolithic occupation phases. The number of typical Neolithic tools, such as polished flint axes, large regular blades with retouch or not, and bipolar pieces are all very limited. This suggests that the activities performed during the Neolithic occupation phase were very limited at the river dune sites in comparison with the levee sites.

The polished flint axe fragments suggest the axes were not present at the sites as intact tools, only in smaller fragments, presumably already as debitage material. This means the flint axes could not have been used for felling trees or other types of wood working as they existed only as debitage material at the site.

Even a few rare items hold information on the nature of the Swifterbant sites. The unfinished pendant of site S4, the only unfinished pendant at that levee site, may suggest extended periods of habitation. The presence of three tooth pendants and raw material to produce stone pendants underline this idea.

The hammerstone in trench S22, along with somewhat similar objects from site S3, suggests the knapping of flint. Hammerstones may also be used to process food or plant material, even colorants. As the hammerstone possibly belongs to the Mesolithic occupation phase, it is unlikely to have been used for other activities such as the production of temper or the roughening of grinding stones.

5.7.4 Technology, method and technique
The distinction between the levee sites and the river dune sites in this section is more than a geomorphological division. The chronological implication is of great importance as well. The purely Neolithic habitation on the levee sites provides a closed technological set, whereas the river dune sites are clearly of Mesolithic tradition but with an unknown amount of Neolithic admixture. As said, the analysis of trenches S21-S24 has been postponed to the end of the analysing period of this Ph.D. for various reasons (see catalogue section 2.2.6). The dataset of the analysed sample of this site might have provided in the characteristics to separate the two technologies, but without the reference material of trenches S11-S13 there is no way to know for certain. The difference between the two sets, i.e. levee sites and river dune sites, may not have been studied in detail, but some characteristics are discernible by a simple but close inspection.

The Neolithic flint technology of the levee sites is characterised by the use of small nodules of roughly 10 to 50 mm with very limited core preparation or rejuvenation. Some larger cores do exist, but they do not seem to be exploited at the sites. Thus, the production on the sites was limited to that of flakes and blades of rather small dimensions.

Nodules were opened by a single blow in order to decapitate the core and install a simple platform, or a single blow could be positioned on a suitable, natural surface to create some sort of guiding ridge or guiding flake. Flake debitage was used in the initial stages of reduction, while the production of small blades was carried out once a guiding ridge was created. Yet, blade production was carried out with only a little more care and preparation. The limited size of the cores resulted in the small number of removals, most cores did not make it beyond the initial stages of reduction, and the rather quick abandonment of the cores as rejuvenation could not successfully be carried out on such small cores. Therefore, the production planes needed to be maintained by reorienting the core a quarter or half a turn.

Besides platform cores, nodules were used to produce bipolar pieces. The presence of natural surface on these pieces, and their actual size, indicate that the smallest nodules were used for this type of artefact. Still, the flake and blade scars cover more often the full length of the production plane compared to the platform cores. Additionally, even though the bipolar flakes have similar lengths but lesser widths compared to the unidirectional flakes, it appears that the success rate of usable flakes per 'core' is higher for the bipolar pieces than for the platform cores, indicating that the bipolar technique is a better adapted debitage technique for small nodules.

The two large cores on site S4 imply that the larger nodules were all used as platform cores. It is indeed more likely that they were the first to be used, just because of their larger size. Subsequently, the smaller nodules remained unused at the site, as is also the case for site S3, or were used for the bipolar technique.

Besides this 'on-site' production of small flakes and blades, large regular blades were produced 'off-site', i.e. production elsewhere. It was observed clearly at sites S2 and S51 (see conclusions in sections 5.2.2 and 5.2.7) that the cores and rejuvenation pieces are insufficient in number and length to produce such long blades. Even more, none of the cores present at the sites show any sign of systematic blade production. The cores are neither depleted nor reworked blade cores as most of them still show remnants of cortex or patina.

Whether this 'off-site' production was in the vicinity, that is on one of the unexcavated levee or river dune sites in the Swifterbant area, at the flint procurement sites, or in some other camp or place of residence within the Swifterbant territory is currently unknown. It is established that the flint types do not differ from the other material used at the sites, only that the material is bigger, suggesting similar procurement sites and the selection of specific, large nodules. The presence of a few larger cores and nodules, up to 70-80 mm and even 100 mm, at the site confirm the existence of such large nodules and suggest their presence at the procurement sites. Whether this limited representation of the large nodules at the sites also indicates a strain or at least a limitation in numbers at the procurement sites is not known.

The blades are generally longer than the 'irregular blades', have parallel edges and mostly two ridges. Some of them are plunging, or may have a lip, indicating production with indirect percussion (Sørensen 2006), all suggesting the need of better knapping skills when one wants to be able to produce these blades. In this perspective the very large crested blade with rounded tip (site S3) is possibly proof that a better knapping technique was mastered, at least if we consider the crested blade to be an 'off-site' produced piece and not a ready-made artefact picked up somewhere or a truly 'exotic' import product obtained by (gift-) exchange.

One of the main characteristics of flint technology that is studied most is the relationship between the flake and blade debitage. This study reveals significant differences between the river dune sites and the levee sites. In sections 5.7.1 and 5.7.2 it was already stated that even though on all sites flake production prevails, the proportion of blade production is larger on the river dune sites than on the levee sites. Thus, during the Neolithic the local production of blanks deteriorated somewhat. On the other hand, a more specialised technique of producing large regular blades emerged, though not on the sites themselves.

Besides these general observations that are related to cultural aspects, small differences between the levee sites themselves are attested. The amount of regular blades is high for sites S2 and S51, and much less for sites S3 and S4. When these blades are excluded, the flake / blade ratio is more equal on the different levee sites (see table 5.37). The exception is site S51 where even fewer blades were produced than on the other sites.

The fragmentation rate, analysed here for flakes and blades, differs per site and may be related to different intensities of heat exposure and blank selection for tools. For sites S3 and S4 this relation is c. 45% versus 55% for the intact versus the fragmented flakes, and 40% versus 60% relation for the blades. For site S2 there is a remarkably high fragmentation rate for the blades (91%); for the flakes this also applies but is less pronounced (c. 35% versus 65%). One of the possible explanations is the more pronounced heat exposure at site S2. Site S51 has 40% versus 60% for the intact and broken flakes and 20% versus 80% for the blades, a case in between. The retouched blades may form a good artefact type for comparison. The overall percentage of broken retouched blades is larger than for the unretouched counterparts, yet again, sites S2 and S51 show the highest levels of fracturing in comparison with sites S3 and S4.

It was observed that although fragmentation leads to an equal amount of proximal and distal parts, not necessarily to an equal amount of medial parts, their numerical presence is not equal at the sites. The dominance of medial parts over proximal-medial is distinct on sites S2 and S4, and nearly equal on site S3. At these three sites the medial-distal parts are always the fewest, especially at site S4. Again site S51 is different; medial-distal parts outnumber the proximal-medial and medial parts.

The high number of medial parts can be interpreted in two ways. The medial part of blades could be created not by breaking off the proximal and distal parts, but by breaking the medial parts into smaller sections as well, thus creating more medial parts than proximal and distal parts. Yet, the large size, i.e. length, of many of the blade fragments may suggest otherwise. Another way of generating an imbalance is the use of proximal-medial or medial-distal parts as blanks, more often than medial parts. Proximal-medial parts are indeed most often observed for the retouched blades on sites S3 and S51, yet the medial parts still prevail on sites S2 and S4. For the blades with visible use-wear traces the proximal-medial parts are dominant at sites S2 and S4, whereas medial parts occur more often at sites S3 and S51, thus the other way round. The altered relation between the different types of blade fragments might suggest another selection process of blanks per activity and/or tool in combination with a certain area or site.

As the general morphological characteristics of the blanks and the tools are the same, we might say that the produced blanks were satisfactory or that the debitage production fulfilled the needs of the Swifterbant people. The tools have the same dimensional range as the blanks but are generally a few millimetres smaller. Yet, it may be observed that for some tools, for example for the rejuvenation pieces, the largest blanks were chosen to be used as tools. The same applies to the regular blades.

Finally, a number of debitage errors have been encountered at all sites. However, these remain limited in number. These attested debitage errors are, besides step and hinge fractures, defined as plunging flakes and blades, double bulbs, obliquely detached blades, and blade-rejuvenation combinations. Research has revealed that error rates that stay below 7% or 8% are acceptable even for experienced flintknappers.

The Mesolithic flint technology of the river dune sites is focussed on flake production, yet blade production occurs at the site as well in fair amounts. The flakes, but mainly the blades, are smaller and more slender when compared to the Neolithic specimens. Small blade cores with straight and narrow bladelet negatives have been found. The absence of the large regular blade technique may also be observed. The few large regular blades found at the river dune sites indicate the use of the sites in Neolithic times. The same accounts for the bipolar debitage technique and the bipolar pieces, all very rare at the river dune sites.

The distinction between blades and bladelets was not made during this research (see section 3.1.2). To differentiate the Mesolithic from the Neolithic blades it might be a useful analytical tool, especially as the production of large, regular blades was attested for the Neolithic occupation phase. Yet blades smaller than 5 cm were also produced during this Neolithic phase. So the use of the terms blade and bladelets would not enable us to make a difference between the little Mesolithic specimens and the little Neolithic specimens made at the settlement sites, it would only allow us to set aside the large, regular imported Neolithic blades.

Conclusions

The applied technique of little core preparation and rejuvenation for the production of small flakes and blades at the levee sites, combined with the use of small nodules for bipolar pieces, may be seen as a consequence of the small sizes of these nodules. However, larger nodules did exist so the transport of smaller nodules to the site was presumably a conscious decision. Therefore, the use of these specific debitage techniques may also be a conscious decision. Maybe there was no use of the larger nodules at the sites, as maybe nobody present at the sites knew how to produce large regular blades. In any case, evidence suggests the larger nodules were knapped elsewhere by people who mastered this specialised technique of producing large regular blades. Additionally, finished blades are easier to transport than large nodules.

5.7.5 *Mobility, territory and raw materials*

The different flint types used at the Swifterbant sites may be described as being of lesser quality, not necessarily of poor quality but certainly not of the best quality. Characteristics such as internal fissures and rolled cortex point to the secondary context of the procured raw material (see section 5.3). The occurrence of bryozoans in a considerable part of the assemblage indicates the outcrops of northern flint as the primary procurement areas.

Even though some flint artefacts show affinities to southern flint types, i.e. some artefacts may have a southern feel about them because of their colour and consistency, there has been no positive identification of southern material as such. Exceptions to this may be the polished flint axe fragments and a few large detachments, for example the flake and blade from trenches S21-S24. Yet the material that may possibly be of southern origin is very limited. Possibly this is related to the distance between Swifterbant and the southern flint outcrops. The farther the distance, the rarer the material. It may even be argued that the fragmentation rate of polished flint axes increases as the distance to its place of origin also increases. For instance, polished flint axe fragments from the Middle of the Netherlands, for example at Brandwijk and Hazendonk, but also at Schipluiden, are much larger than at Swifterbant.

It has already been stated that certain varieties of flint cannot be retraced to specific outcrops. It is therefore not unlikely that procurement areas other than the boulder clay outcrops within the Swifterbant territory were exploited.

The Swifterbant territory can be divided into several action radiuses. Closest to the settlement site or base camp is the camp radius, beyond lies the site territory or foraging zone for daily activities such as gathering food and other subsistence supplies, while the logistical zone lies beyond. The year territory of visited areas or camps within a one year cycle may also be defined as the extended range and the sphere of influence or visiting zone reaches as far as resource expeditions go or the network of contacts reach as seen in the exchange of exotic materials (Bakels 1978, Binford 1982, Houtsma et al. 1996, Higgs & Vita Finzi 1972, Louwe Kooijmans 2001a, Newell et al. 1990, also see section 4.8.4).

The site territory or foraging zone is the area around the site that is normally exploited by the inhabitants. The distance travelled to gather food, raw materials, or other supplies may be set at 10 km (see section 4.8.4). Suitable procurement sites of northern flint within this range are the boulder clay outcrops of Urk (10 km) and Schokland (14 km). As the outcrop of Schokland is located somewhat farther away, this possibly required a two-day trip, especially when several hours of foraging time are included. Other outcrops in the Noordoostpolder, like Tollebeek and De Voorst, or just beyond are likely sources as well.

The second distance to be travelled, the foraging zone, is the 6 hour walking distance or a 30 km action radius. Sources of flint at the limit of this travelling distance are the Veluwe (30-70 km). A second area, the Utrechtse Heuvelrug at 40 to 70 km would imply a three- to four-day travel back and forth. Both areas are known to hold small amounts of northern flint, even though they are a main source of southern flint material. These are therefore likely procurement areas of the ‘unspecified’ flint types.

The largest radius, the sphere of influence or visiting zone, is suggested by the polished flint axe fragments and set at 150 km or more. Traditionally these axes are interpreted as products of the Michelsberg culture. As none of the flint types could positively be identified as southern and the original shape of the axes could not be reconstructed, there is no way of knowing these axes are truly of southern origin. Since local copies of typically southern stone axe types have been identified, there seems to be no reason to think this could not happen to the flint axes. Therefore, it may be clear that the flint type analysis gives less clear indications of specific outcrops or procurement sites compared to the stone material.

5.7.6 Heat exposure

On the levee sites in general, the total flint material, small and large artefacts together, show roughly 30% of burnt specimens. This is more specifically c. 30%-40% for the artefacts ≥ 1 cm and c. 30% of the artefacts < 1 cm.

In more detail, at site S2 the highest number of burnt artefacts is discernible (52%), on the other sites this is between 30% and 38%. This high number is especially the result of the artefacts < 1 cm where this number reaches as high as 62%. Also up to 48% of the artefacts ≥ 1 cm are burnt which is the highest percentage on all sites. This high number of heat exposed artefacts is remarkable especially considering the absence of clay structured hearths at site S2. Clay structured hearths have, however, been observed on site S3, one of the sites with the lowest percentage of heat exposed artefacts. Thus, the high number of burnt artefacts suggests the presence of another type of hearth at site S2, maybe some form of surface hearths, or a specific treatment of the material or certain special activities.

The percentage of burnt chips on sites S3 and S4 is only 29%. Thus, even if very large amounts of chips are present at site S4, their percentage of heat exposed specimens remains the same as site S3. However, the percentages of the artefacts ≥ 1 cm are somewhat elevated. The 62% of site S2 is only rivalled by the 55% of site S51, both quite exceptional. Thus again, site S51 is somewhat different. The amount of burnt artefacts ≥ 1 cm is, however, comparable to that of site S3.

For the different artefact categories, the percentages tend to fluctuate. On site S3 the percentage of heat exposure is the same for the debitage material as it is for the tools. On site S2 and S4 the debitage is slightly more burnt than the tools, on site S51 this is reversed.

It has been noted that flake and blade fragments are more often burnt than their undamaged counterparts. As heat exposure leads to fragmentation, it is partly the burning that is the cause of the high fragmentation rate. This phenomenon was observed at all sites.

The waste material was on all sites exposed to heat most often; this is because of the potlids. But when these are excluded the number remains high on all sites, these are 57% (S2), 39% (S3), 58% (S4), and 46% (S51). The artefacts with visible use-wear traces are burnt less often on site S3 than on sites S2 and S4, with a low number on S51. The bipolar pieces seem to be exposed to heat in different percentages at all sites ranging from 4%, over 16%, to up to 35%.

For all artefact categories, even for the chips, moderate heat exposure occurs most often. Light heat exposure appears the least. Besides, it is also the hardest to detect, which might have contributed to the low number.

The river dune sites show an even more complex picture. Site S61 has the lowest number of heat exposed artefacts of all sites. This is attested for all artefact categories at the site. The larger artefacts of sites S80-S84 are also little exposed. Yet, the percentage of heat damaged chips is nearly as high as on site S2. From trenches S21-S24 only the larger artefacts have been analysed in the sample, yet it may be clear that the percentages are quite high compared to the other two river dune sites, they are nearly as high as on site S2. My initial thought was that the lesser heat exposure on the river dunes, compared to the levee sites, is the result of a different type of soil, i.e. sand compared to a clayey substance, or different types of hearths, but this is annulled by trenches S21-S24. The difference is more likely to be culturally based. Mesolithic life ways maybe resulted in less heat exposure. As trenches S21-S24 show the largest Neolithic admixture in the flint assemblage, in combination with a Neolithic cemetery, a high level of heat exposed artefacts may be expected as on site S2. Thus besides the chips, sites S61 and S80-S84 are the most alike and show the lowest percentages of heat exposed artefacts while trenches S21-S24 are comparable to the levee sites.

The heavy heat exposure of site S2 is one of the main conclusions. This high number is only rivalled by the chips of site S51. Yet, the artefacts ≥ 1 cm of trenches S21-S24 are very similar to site as S2 as well. The other sites show moderate numbers of heat exposed artefacts. The lowest number is found on sites S61 and S80-S84 which possibly might be a Mesolithic characteristic. The tendency that more tools are burnt than any other artefact category as seen for the stone assemblage does not hold for the flint artefacts, their percentages tend to fluctuate per site. The only constant is the high number of burnt waste material.

Thus, on a more general note, of most artefact categories approximately 1/3 is burned. This might differ a few percentages but it is mostly 1/3 or less.

5.7.7 Conclusions

The flint assemblages from the different sites at Swifterbant suggest a diverse use of the area over long periods of time. The river dune sites were inhabited during different phases of the Late Mesolithic whereas the levee sites were occupied during the Middle Neolithic. Proof of limited use of the river dune sites in the Middle Neolithic was discovered as well.

The habitation must have comprised of extended periods of time by complete households. The flint production provides evidence of highly skilled knappers but also of less skilled people and possibly even apprentices. Even more, the cemeteries show the full scale of ages and sexes associated with complete households. The artefact composition reveals numerous and very diverse tools for performing many daily tasks from maintenance activities to hunting, gathering and fishing, traditionally seen as female and male tasks respectively.

All the sites must have been part of the site territory although not all sites were used in the same intensity in all habitation phases. Some sites were preferred for specific tasks, while other sites functioned as base camps. But not all resources were readily available in the near surroundings. Stone and flint needed to be collected from some distance away. The appearance of the raw material and its composition suggests the boulder clay outcrops as the primary source for gathering flint. The outcrops of Urk and Schokland (10 and 14 km), but possibly also the other outcrops in the Noordoostpolder and neighbouring areas, are located within a one- or two-day trip's reach. As the Swifterbant sites are located in the river system of the palaeo-IJssel and the boulder clay outcrops in the river system of the Vecht, the acquirement of flint must have been less easy than first assumed. The river systems are not connected yet both flow out into the sea. Travelling some distance over land or a long way around over water must have been inevitable.

A supplementary flint source may have been the Veluwe and the Utrechtse Heuvelrug (30 and 40 km) accessible in a three- to four-day travel back and forth. The use of these procurement sites is only assumed and not proven by the presence of typical flint types at the sites. The same applies to the sphere of influence that may have reached at least 150 km southwards into the territory of the Rössen and Michelsberg culture. Yet, no direct evidence of southern flint was encountered as none of these flint fragments associated to the south are positively identified as a specific type of southern flint. The southern character of the flint is only implied by the nature of the tool, i.e. polished flint axes.

The raw material distribution for the different types of debitage material, i.e. flakes, blades, rejuvenation pieces, and the cores is very similar at all levee sites. This is c. 60% for fine-grained flint without bryozoans and c. 20% for fine-grained flint with bryozoans. Even the medium- and coarse-grained flint types are represented by the same percentages.

The raw material distribution for the different tool types is also very similar at all levee sites. Only minor fluctuations are visible, which are often the result of different percentages of heat exposed specimens. Thus, well pronounced preferences of a certain type of flint for a certain type of tool are very limited or even non-existent. Most tool types show roughly the same distribution. Fine-grained flint without bryozoans is always most often used (c. 60%) while fine-grained flint with bryozoans always takes second place (c. 20%). Medium- and coarse-grained flint occurs in nearly every tool type, yet in limited amounts. The only tool type not showing any medium- or coarse-grained flint is the borers. As these are one of the rarest types of tools at the sites, this may be related to their general low number. But even in the absence of medium- or coarse-grained flint the two types of fine-grained flint are similar in percentages on all the levee sites. This is the result of the high percentage of burnt specimens; a number only exceeded by the tool fragments. Thus, the selection of the blanks is representative of the overall distribution of the material, in other words, no selection of specific raw material types took place for certain artefact types.

This is, however, not the case for the dimensions of certain types of blanks for certain types of tools; these are clearly selected for their exceeding lengths. The tool size is generally in correspondence with the blanks indicating the production of these tools from the blanks present at the sites. The only exception is formed by the tools on the large regular blades. Thus, the produced blanks, both on- and 'off-site', were satisfactory in dimensions for the tools needed at the sites or alternatively, the debitage production was in conformity with the needs of the Neolithic Swifterbant people. The larger rejuvenation pieces and regular blades were chosen to be used for tools; all the other blanks are a variety from the scope of blanks available.

For the river dune sites, all the retouched artefacts fall within the dimensional limits set by the unretouched blanks, even the rejuvenation pieces. Thus flakes, blades, and rejuvenation pieces are adequate or sufficient in size to produce the required tools. The raw material type, however, shows more inclination towards selection than on the levee sites. One of the clearest examples are the Mesolithic microliths. Here fine grained flint without bryozoans rises up to 85%, all against the fine-grained flint with bryozoans that falls to the lowest minimum of 4%.

It may also be observed that when medium- and coarse-grained flint occurs, this is mainly at the levee sites. Up to 94% of the medium-grained flint was found on the levee sites; this is 92% for the coarse-grained flint. The near absence of these two types at the river dune sites is observed in the debitage material as well as for the tools. Trenches S21-S24 form the exception, possibly because of the higher admixture of Neolithic artefacts (see section 4.8.1). It was also observed that the selective gathering of flint extents towards smaller and lesser bryozoans during the Mesolithic, a more careful selection of raw material types and nodules. These high percentages may also reflect an exhaustion of the better quality flints at the procurement sites during the Neolithic or a less careful collection in those times. Thus, the preference of fine-grained flint without bryozoans is attested at all sites, yet especially visible on the Mesolithic river dune sites.

It should also be mentioned that the larger blades and flakes, mainly present at the levee sites, are of the same raw material composition and colour as the other flints at the sites. This suggests the same procurement sites yet a 'better quality of flint'. Thus, during the Neolithic the larger nodules were reserved for the production of large, regular blades possibly by skilled specialists 'off-site'. This material may have had less internal fractures, hence the idea of the best nodules for large blades, but as only the best blades are taken to the site, and the waste material and failures are not visible this is only an assumption. At the levee sites, small and lesser quality nodules were used for flake and limited blade production. Yet, these nodules were clearly sufficient for the production of bipolar pieces.

Thus, the raw material selection and the size of the tools are on the levee sites in correspondence to the blanks indicating the production of these tools from the blanks present at the sites, even if for certain tools exceeding lengths were preferred. For the river dune sites evidence of selection was also observed, yet only in raw material type.

The composition of the flint material, and more specifically the debitage material and the tools, suggest the different use of the sites. Additionally, the presence of material from the different occupation phases on the river dune sites versus the levee sites gives supplementary information. All levee sites except S41 yielded sufficient amounts of material for a mutual comparison. Site S41, with its limited number of flints, may only be compared to the others in a general way. The river dune sites are somewhat more problematic as there are only three.

The four levee sites S2, S3, S4, and S51 show several similarities yet show a clear dichotomy as well. The debitage material always forms the largest part of the artefacts ≥ 1 cm and is predominantly unidirectional. The waste forms the second largest group and the tools are always third. Yet, small or larger differences in numerical presence of these artefact categories and tool compositions give them an individual character. Depending on the aspect studied, sites will correspond with other sites in different combinations. For example, site S3 shows a dominance of debitage material and a low tool count while site S2 shows the opposite. The same applies for the amounts of bipolar pieces and the artefacts with visible use-wear traces. Additionally, most often site S51 corresponds best to site S2 while site S4 relates best to S3. Yet, cemeteries occur only on sites S2 and S4.

It should also be mentioned that the presence of blades at a site does not necessarily mean the production of these blades at that site. This flint research revealed that the large regular blades were produced somewhere other than on the studied sites. The amount of these regular blades is high for sites S2 and S51, and much less for sites S3 and S4. When these blades are excluded, the flake / blade ratio is more equal on the different levee sites. The exception is site S51 where even fewer blades are produced than on the other sites. Additionally, for site S2 there is a remarkable high fragmentation rate for the blades and to lesser extent for the flakes. One of the possible explanations is the more pronounced heat exposure. This high percentage of heat exposed artefacts is by itself remarkable especially considering the absence of clay structured hearths at site S2. Clay structured hearths have however been observed on site S3, one of the sites with the lowest percentage of heat exposed artefacts. Thus, the high number of burnt artefacts suggests the presence of another type of hearth at site S2, maybe some form of surface hearth, or a specific treatment of the material or certain special activities. The presence of a cemetery at the site seems of significance here. Even more, as trenches S21-S24 show the largest Neolithic admixture in the flint assemblage, in combination with a Neolithic cemetery, a high level of heat exposed artefacts may be expected as on site S2. The high exposure rate of the artefacts ≥ 1 cm at site S4 may also be related to the grave found at the site. The statement that because of the amount of burnt chips a cemetery must have been present at site S51 seems a bridge too far as the general number of chips is rather small.

In tool composition the four levee sites show no large differences, yet the percentages of these different tool types suggest the focus on different activities per site. The wide range of tools may be used at a base camp as part of the daily activities or maintenance activities such as hunting, gathering and preparing food, processing hides and plant material, or even working with wood, antler, bone, or even mineral substances and stone. Some sites have clear preferences. Sites S3 and S4 are very similar with a dominance of scrapers. At site S2 the dominance of retouched blades is, however, combined with a high percentage of blades with visible use-wear traces. It appears that plant processing activities were more important than possibly hide working, one of the most common activities performed with scrapers. Site S51 is remarkable in the respect that it has the highest percentage of scrapers as well as the highest level of blades with visible use-wear traces. This site appears to be specialised in 'two specific activities'.

More remarkable is the presence of polished flint axe fragments on sites S3 and S4, and their absence at sites S2 and S51. Even more, the presence of only smaller axe fragments suggest the axes were not present at the sites as intact tools, only as little fragments, presumably already as debitage material. This means the flint axes were presumably not used as tools, for felling trees or other types of wood working, only brought in as smaller fragments, i.e. debitage material. This does not mean the axes were not imported from the south, although this cannot be corroborated with absolute certainty as the original shape, i.e. type, could not be reconstructed, neither could the raw material type positively place the origin in the south. As stone axe copies were produced locally, maybe flint axes were produced locally as well, although then larger fragments would be expected. One significant difference is that there seems to be a clearly differential treatment of the stone and flint axes.

All these aspects combined suggest a domestic or residential use of sites S3 and S4, possibly a main site and an annexe with some differences in use indicating the supplementary functions of the sites, and a specific use of sites S2 and S51 for certain activities performed with retouched blades on the one hand and scrapers and tools on blades on the other. The two latter sites also show the largest percentages of imported regular blades. Consequently, it may be presumed that these blades were specially produced to perform these specific tasks.

One exception that sets site S4 aside from the other levee sites is the high number of chips, a characteristic it shares with river dune site S61. Even though certain distinguishing trends have been observed between the chips from the levee sites and those of the river dune sites, the large amount of chips at sites S4 and S61, combined with their similar appearances, remains largely unexplained. The presence of the different hoe-fields at site S4 is presumably of no relevance here as they are also attested at sites S2 and S3.

Little can be said about site S41. The flint material present at the site is in concordance with the other levee sites. The selection of the raw material, the composition and mutual proportions of the different artefact groups, the debitage system, and even the composition of the tool kit suggest a very similar use of the site. Whether the site must be interpreted as a domestic site like S3 and S4 or as a special activity site as sites S2 and S51 cannot be answered by this little set of artefacts. It is very likely that other levee sites such as sites S31 and S42-S43 have had similar forms of occupation. The mutual relation between S3 and S4, seen as some sort of main site with annexe having complementary functions, may even exist between sites S41, S42 and S43. Their proximity might suggest this, just as the location of site S3 together with site S4, and the isolated position of both sites S2 and S51 may be an explanation for the differences and similarities between these four sites.

In several aspects the river dune sites S21-S24, S61, and S80-S84 differ from the levee sites, although some similarities in certain preferences may be observed, i.e. the preference for fine-grained flint without bryozoans over fine-grained flint with bryozoans. One of the main differences between the river dune sites and the levee sites, or the Mesolithic versus the Neolithic occupation phases, is in the raw material selection. Several other aspects of the flint analysis confirm a selective gathering of a better quality of flint during the Mesolithic compared to the Neolithic, i.e. the selection of flint with smaller and lesser bryozoans. The better quality flint was used for the daily production of flakes and blades at the sites, but also for the tool production. Even more, certain types of tools are nearly exclusively produced out of the better quality of fine-grained flint. In contrast, during the Neolithic the lesser quality flint types (smaller nodules) were taken to the sites for local flake production while the larger cores were selected for specialised blade production elsewhere or 'off-site'. It may even be argued that the medium- and coarse-grained flint artefacts present on the river dune sites may be of Neolithic origin. Medium- and coarse-grained flint types are generally rarely used; at the river dune sites they are almost absent. Even more, medium- and coarse-grained flake and blades were most likely not even produced at the river dune sites as no rejuvenation pieces, cores, or nodules of such types of flint have been recovered from any of the river dune sites. These were only retrieved from the levee sites, and, more specifically, mainly at sites S3 and S4. The hypothesis that a very large part, and maybe even all, of the medium- and coarse-grained flint artefacts at the river dune sites are of Neolithic origin may be proposed as they are all (frost) flakes, blades and (Neolithic) tools. Only one microlith clashes with this hypothesis. Even more, the hypothesis explains their near absence at sites S61 and S80-S84. The higher representation of these flint types at trenches S21-S24 is the result of larger admixture, also observed in several other aspects of this study.

More differences are observed in the debitage technique. Although the Mesolithic flint technology of the river dune sites also focussed on flake production, blade production occurs at the sites as well in fair amounts. The flakes but mainly the blades are smaller and more slender compared to the Neolithic specimens. The cores on the river dune sites are also somewhat smaller than on the levee sites. The few large regular blades found at the river dune sites indicate the use of the sites in Neolithic times. The same applies to the bipolar debitage technique, the bipolar pieces and the polished flint axe fragments, all very rare at the river dune sites.

The relationship between different sites when specific aspects are analysed is also revealed. Most often sites S61 and S80-S84 are similar to each other while trenches S21-S24 often resemble the levee sites. This might suggest that the admixture of Neolithic artefacts is much larger in trenches S21-S24 than on sites S61 and S80-S84. This is illustrated not only by the presence of polished flint axe fragments and bipolar pieces, but possibly also by numerous heat exposed artefacts and the presence of a Neolithic cemetery. On the other hand, the low number of heat-damaged artefacts at site S61 may be observed as well. When artefact categories are compared, the very high number of debitage material and very low number of tools makes site S61 the extreme version of levee site S3. Also the flake / blade ratio is very similar on both sites. Even more striking is the total absence of scrapers within the toolkit, just as the absence of (large regular) blades within the artefacts with visible use-wear traces. Whether this is a true image or the result of the low number of tools cannot be determined. Nonetheless, these aspects suggest the specific character of the site focussed on the knapping of flint and far less on performing certain other daily activities preformed with scrapers or large blades. In this respect, sites S80-S84 resemble the domestic levee site S3 the most.

Chapter 6

A summary and interpretation

6.1 Stone meets flint: a synthesis of the Swifterbant type site

6.1.1 Introduction

After the separate analysis of the stone and flint artefacts of the Swifterbant type site, the lithic material is brought together and compared. This results in clear images of different preferences and diverse site functions.

First a quick overview of the site's main characteristics is given. For a more detailed version I would like to refer to chapter 2. Then the lithic industry is reviewed and finally all aspects are brought together in a comparison and a conclusion.

6.1.2 Swifterbant site S2

General aspects

This site is located on a levee along the main creek and has an isolated position. The cultural layer, covering an area of 24x50 m and being c. 25 cm thick, appears to be intact and was sealed off shortly after the occupation. The division into two layers, visible by a sterile clay deposition at the east end of the site, suggests an interruption in the occupation history. The old research resulted in the excavation of c. 435 m^2, which is 54 % of the cultural layer; the recent excavation added some 26 m^2 or 3%.

The radiocarbon date on charcoal from the occupation layer sets the habitation at c. 4250 - 4000 cal BC. This date, along with the stylistic characteristics of the pottery, places the occupation of the site in the Middle Swifterbant phase. As the levees were only habitable between c. 4360 cal BC and 3800 / 3700 cal BC, no other cultural presence was possible.

Most of the archaeological remains from the different excavation campaigns have been studied. The pottery has been analysed integrally and thoroughly (see Raemaekers 1999, de Roever 2004). Approximately 7000 potsherds have been found, all with the same characteristics as the pottery found on site S3. Also studied are the nine graves and several loose human skeletal remains and teeth (Meiklejohn & Constandse-Westermann 1978, Constandse-Westermann & Meiklejohn 1979). In the past, the number of bone fragments was considered too low to be worth analysing (Clason & Brinkhuizen 1978: 69), yet in recent years they were analysed as part of the new research campaign (Prummel et al. 2009). The other finds, none of which have yet been studied, comprise a row of eight wooden stakes, at least two additional wooden stakes, pieces of charcoal, and possibly also other organic remains.

Lithic artefacts

The lithic industry consists of 3155 stone artefacts and 1386 flint artefacts (tables 6.1 and 6.2). This means that approximately half as many stone artefacts are present than flint artefacts (69% versus 31%). In the weight distribution this is even more extreme as 19,917.1 g was attested for the first group and 2259.06 g for the second

Table 6.1 Overview of the amount of stone and flint artefacts per site.

	Stone				Flint				Total
	< 3 g	*≥ 3 g*	*Total*	*%*	*< 1 cm*	*≥ 1 cm*	*Total*	*%*	
S2	2,625	530	3,155	69%	359	1,027	1,386	31%	4,541
S3	8,563	2,255	10,818	30%	9,194	16,171	25,365	70%	36,183
S4	17,846	557	18,403	83%	2,218	1,484	3,702	17%	22,105
S21-S24	590	475	1,065	5%	1,564 *	2,085 *	19,311	95%	20,376
S41		3	3	5%	2	57	59	95%	62
S51	241	51	292	57%	65	152	217	43%	509
S61	2,546	18	2,564	58%	1,043	794	1,837	42%	4,401
S80-S84	2		2	1%	62	171	233	99%	235
Total	**32,413**	**3,889**	**36,302**		**14,507**	**21,941**	**52,110**		**88,412**

* This material is only the studied sample from the site. If the remaining material would be included, this number would be higher still (see appendix table 2.13).

Table 6.2 Overview of the weight of stone and flint artefacts per site.

	Stone				Flint				Total
	< 3 g	*≥ 3 g*	*Total*	*%*	*< 1 cm*	*≥ 1 cm*	*Total*	*%*	
S2	846.6	19,070.5	19,917.1	90%	48.96	2,210.10	2,259.06	10%	22,176.16
S3	4,377.9	115,211.5	119,589.4	84%	1,150.63	21,194.64	22,345.27	16%	141,934.67
S4	2,132.0	29,847.4	31,979.4	92%	115.96	2,659.52	2,775.48	8%	34,754.88
S21-S24	642.3	15,709.4	16,351.7	32%	225.89 *	2,901.93 *	34,513.20	68%	50,864.90
S41		237.6	237.6	36%	0.38	416.19	416.57	64%	654.17
S51	62.4	4,902.0	4,964.4	95%	7.10	228.47	235.57	5%	5,199.97
S61	97.0	2,742.5	2,839.5	58%	86.16	1,997.73	2,083.89	42%	4,923.39
S80-S84	1.3	0.7	2.0	0%	6.37	854.01	860.38	100%	862.38
Total	**8,159.5**	**187,721.6**	**195,881.1**		**1,641.45**	**32,462.59**	**65,489.42**		**261,370.52**

* This material is only the studied sample from the site. If the remaining material would be included, this number would be higher still (see appendix table 2.13).

Table 6.3 Overview amount of lithic artefacts and pottery per site.

	Stone		Flint		Pottery		Total
	Total	*%*	*Total*	*%*		*%*	
S2	3155	27%	1387	12%	7000	61%	11542
S3	10818	19%	24922	45%	20000	36%	55740
S4	18403	77%	3702	16%	1626	7%	23731
S21-S24	1065	5%	19311	92%	550	3%	20926
S51	292	17%	217	12%	1270	71%	1779
S61	2564	56%	1837	40%	200	4%	4601

group (90% versus 10%). Thus, the flint material is scarcer than the stone material, both in numbers and in weight.

When all inorganic archaeological remains are taken into account, the dominance of the stone artefacts (27%) over the flint artefacts (12%) fades against the amount of pottery (61%) found at the site (table 6.3).

The stone assemblage shows a large amount of waste, just as the flint material. The high number of chips and the low number of cores indicate that stone knapping was conducted at the site but that certain stages, like the cores, were taken somewhere else or were re-used as tool blanks. Maybe the isolated position of site S2 within the settlement system compelled the people to be more economical in the use of their raw materials. Stone tools with a grinding function outnumber anvils, hammerstones, and axes / adzes, yet all give evidence of a mixture of activities such as grinding cereal or processing other food products, making pottery temper, but also flint knapping and possibly even the production and maintenance of pottery, axes, and other stone tools. Processing hides, wood working, and ornament production would also have been part of the performed tasks.

The flint material is characterised by flake production at the site and the import of finished blades to the site. The latter were preferred as tools, an artefact category well represented at site S2. The retouched blades, the dominant tool type, are combined with a wide set of other tools indicating a variety of activities such as the processing of plant material for food production and crafts, hide processing, and possibly even the production and maintenance of pottery. Noteworthy is the high number of heat exposed flint artefacts, more specifically the chips, debitage material, i.e. flake and blade fragments, and to a lesser extent the tools, especially if we consider that no structured clay hearths were found.

Site function

The cemetery at site S2 immediately reveals one function of the site. However, both Deckers et al. (1980) and Lanting & Van der Plicht (1996b: 505) state that the cemetery was most likely constructed after the occupation of the site, although Lanting & Van der Plicht also write that the contemporaneity of the graves with the occupation is in theory possible.

It is immediately clear that this is not the only function of the site as many other archaeological remains are present, although it is possible that all the other features may be connected to the funerary practices. The row of posts may be interpreted as some sort of palisade forming a wind screen or may be part of a (residential) construction. Hearths have not been recognised as such, because of the drier living conditions there was no need to construct little clay floors as on site S3, yet their presence is attested by the number of heat exposed artefacts. Both lithic artefacts and bone material show traces of heat exposure between 400-550 °C and above (Prummel et al. 2009: 25).

The current NAP values (= Dutch Ordnance Level) of the site, between -5.30 m and -5.50 m according to Fokkens (1978) and between -4.95 m and -5.20 m according to de Roever (2004: 22), are, regardless of this discrepancy, still higher than site S3. This would have led to drier living conditions on site S2. Maybe that is why site S2, in combination with its isolated position at the main creek, was selected as an ideal spot to bury the dead. The similar orientation of the burials suggests the relative contemporaneity of the burials and their long-term visibility in the field.

The limited thickness of the occupation layer suggests a shorter occupation history or a less intense use of the site compared to site S3. Then again, at S3 plenty of reed bundles were deposited throughout the occupation history. The occurrence of a sterile clay band at site S2 indicates the presence of at least two different occupation phases, but the relative dating of these layers is impossible to determine.

Two possible scenarios can be reconstructed. The flint artefacts found in several of the graves point either to the contemporaneity of the occupation with the cemetery or to the later date of the graves. Even more, it is not hard to imagine that even though the site was used in a second phase as a cemetery, other activities, ritual or not, were performed at the site. The sterile clay band indicates a discontinuity in the use of the site, but whether this supports the second hypothesis is open to debate. If both aspects are separated in time, the site might first have been used as a residential site with flint debitage and all sorts of daily activities. In that case, the palisade would have formed some sort of a small housing construction or protection from the environmental elements. At a later date, for example when the cemetery was constructed, the site was only used for specific tasks such as processing plant material, both for food production and for crafts. The dominance of blades and grinding stones might point in this direction. If both aspects were contemporaneous, the dominance of plant processing activities still holds, yet with evidence of a wider range of other activities in lesser numbers. The high number of potsherds might be explained as pottery production or as vessels to be used for food storage like cereals and flour. Whether the high number of heat exposed flint artefacts is to be related to the cemetery, as the result of some sort of ritual, is at this point hard to substantiate.

6.1.3 Swifterbant site S3

General aspects

This is one of the levee sites clustering around the junction of two tributaries in the creek system. The occupation layer, c. 60-75 cm thick, covers an area of approximately 20x38 m. Van der Waals (1977: 17) recognised two occupation phases, the first phase was characterised by repeated flooding which eroded and re-deposited some of the soil, while the second phase gives evidence of a more stable environment. A total of c. 430 m^2 was excavated which is c. 63% of the occupation layer.

The radiocarbon dates generally range between c. 4330 to 3950 cal BC. The only date outside this range is a sample of charred food remains from a potsherd. The radiocarbon dates place the inhabitation phase in the middle Swifterbant phase, which is also corroborated by the stylistic and technical characteristics of the pottery.

As the preservation of the organic material on this site was exceptionally good compared to site S2, a large area was excavated. This resulted in the most numerous amounts of finds from all Swifterbant sites. These comprise, besides lithic material and pottery, organic material such as charcoal, seeds, fruits and other macroscopic plant remains (see Van Zeist & Palfenier-Vegter 1981) but also wooden artefacts such as axe handles (see Casparie et al. 1977) and bone tools such as T-shaped antler axes, shafted antler axes, bone awls, chisels[1] and knives (see Bulten 1988, Bulten & Clason 2001). Combined with animal teeth pendants several different animal species are represented, both red deer[2] and pig / wild boar in larger quantities, and horse, cattle, auroch, and crane in very small quantities. The preference for metapodials from large herbivores may be observed. Even more, the bone industry clearly reflects the faunal spectrum present at the site. The unaltered bone material, i.e. none-tools (the description below refers to Brinkhuizen 1976, Clason & Brinkhuizen 1978, Zeiler 1986, 1987, 1997) contained considerable amounts of large and small, wild and domesticated mammals, birds and fish along with some isolated human remains. Pig and wild boar were hunted and consumed most often; they make up roughly half of the identified bone fragments. Fur animals such as beavers and otters occur moderately, whereas the amount of cattle, red deer, and bird bones is

1 In the original publication (Bulten & Clason 2001) the term gouges is used.

2 These are mainly shed antlers and not fragments of butchered animals (Zeiler 1997).

low. Other animals such as dog, fox, brown bear, wild cat, common seal, horse, sheep / goat, aurochs and elk occur rarely. For most of these species the landscape around Swifterbant was very suitable. Yet, for horse, red deer, aurochs, elk, and sheep / goat the woods in the area may have been too dense and wet. These animals, or remains and tools thereof, were presumably obtained from outside the site territory. Pig / wild boar, cattle, otter, beaver, swans and ducks were hunted or butchered locally and consumed at the site. Otter and beaver were hunted for both their meat and fur; beaver teeth may even have been used as pendants or chisels. It appears wild and domesticated animals were equally important in the diet. Dogs were kept for companionship, or even hunting assistance, and not for food as there is no evidence of butchering or consumption.

The pottery of site S3 comprises roughly 20,000 potsherds and was studied by Raemaekers (1999) and de Roever (2004). These studies indicated the similarity between the pottery from this site and that of site S2. However, recent research (Raemaekers 2011a and b) has revealed a set of potsherds that show different characteristics which might indicate an even later occupation phase at this site, possibly dated between c. 3900 and 3800 cal BC.

Besides archaeological finds, the research uncovered several features such as different types of hearths, along with c. 650 wooden stakes and posts. Within this maze of stakes and postholes, de Roever (2004) could reconstruct the outline of a house. Even more, fourteen of the stakes form a row or palisade outside the house similar to that of Swifterbant site S2.

Lithic artefacts

The lithic industry is made up of 10,818 stone artefacts and 25,365 flint artefacts (see tables 6.1 and 6.2). The stone assemblage is outnumbered by the flint assemblage only in numbers (30% versus 70%); in weight the first represents 119,589.4 g whereas the second only weighs 26,888.60 g (82% versus 18%).

Thus, the inorganic archaeological remains are dominated in number by the flint artefacts (45%), than by the pottery (36%), and the stone material forms the smallest group (19%) (see table 6.3).

The stone tools show the dominance of grinding stones over hammerstones and anvils, whereas combination tools often unite the latter two functions, thus suggesting a wide variety of activities and not the dominance of one specific task.

The high percentage of the flint debitage material and the low number of tools, also observed with the stone tools, suggest a residential use of the site. The toolkit is clearly dominated by scrapers and to a lesser extent by retouched flakes and blades. All other types of tools are rare. The high number of tool fragments suggests intense usage and possibly repair of the toolkit. The tools were locally produced on flakes, blades, and all other types of blanks available at the site. The artefacts with visible use-wear traces are the only category with a clear dominance of blades; regular blades that were imported to the site in a limited number. The bone and antler tools, and their production waste, point to the production and use of these tools as well. Beaver teeth, stone debitage material and flint tools may even have been used in wood working.

All these artefact types produced out of so many different raw materials indicate a very diverse range of activities. These include butchering, plant processing both for food production and for crafts, hide processing, temper production, lithic debitage, ornament production, and bone, antler and wood working.

Site function

The fact that a large proportion of the site has been excavated brings the opportunity of constructing a representative image of the site's function. The absence of a cemetery is one of the main differences with some of the other sites; the presence of numerous wooden stakes, post and post holes is another. With the outlining of a house by de Roever (2004) the residential character of the site was established. Not only the house, but the repeated reconstruction of the house, and thus the presence of different occupation phases are attested.

All archaeological features and remains indicate extended periods of occupation, yet presumably not permanent, throughout all seasons of the year (Zeiler 1997). The thick occupation layer may point towards a long overall occupation history, a preference for this site and an intense use. On the other hand, it may just be evidence of raising the occupation floor. It was often believed that reed bundles were brought to the site to avoid wet living conditions (Deckers et al. 1980). These conditions could not have been that wet and muddy if people kept returning to the site. The rebuilding of the house on the same spot, with the same location of the central hearth clearly indicates a favourable spot. The bundles of reed can therefore be interpreted functionally, to be more comfortable on a damp floor, or even ritually, to cleanse the site before reconstruction the new house and hearth. Consequently, the wet living conditions possibly did not prevent the site of being chosen as cemetery - nobody likes to bury their dead in a puddle of mud or a flooded grave - but possibly the favourable location as a settlement site did. Even more, site S4 is currently located even lower and it had the grave of a child. Yet, site S4 may have been subject to different degrees of settling of the clay than site S3. Even more, reed bundles have also been attested at site S4 (pers. comm. D. Raemaekers 2012). All in all, the wide variety of tools, both organic and lithic, indicates the highly residential character of the site. Alternatively, the presence of the house may imply the site was a settlement where tools were produced to be used in other locations.

6.1.4 Swifterbant site S4

General aspects
This site is also a levee site located at the conjunction of two tributaries in the creek system and is approximately 60 m to the northeast of site S3. Three occupation phases were recognised by Van der Waals (1977: 24) and described by him as a thin, basal occupation layer of c. 6 cm thick characterised by repeated flooding and erosive periods; a second occupation layer of 30 cm thickness with clear erosive and flooding phases in the lower parts of the layer; and a third, thin layer of 5 cm in the west. The first and second layers are nowadays known as the hoe-field and the successive (main) occupation phase. The third layer mentioned by Van der Waals is no longer mentioned by Deckers (1979: 159) and may be the result of a modern disturbance. This could however not be verified in the recent excavation campaigns. These campaigns resulted in the excavation of at least 120 m^2, which forms, along with the c. 16 m^2 of the old campaign, c. 23% - 33% of the cultural layer.

Most of the radiocarbon dates at the site fall within the range of c. 4350 and 3970 cal BC. The final date of 3700 cal BC is slightly later than the others. Yet, all dates fall within the range of the middle phase of the Swifterbant culture.

The archaeological evidence comprises lithic finds and pottery. Of the latter 1626 potsherds were found showing the same characteristics as those on site S3 (de Roever 2004: 59). A total of 467 were collected at the old excavation, while the remaining 1159 potsherds were recovered during the recent excavation campaigns. Also charcoal, hazelnuts and other types of plant remains, as well as large amounts of animal bones, have been uncovered. Some specific features such as wooden posts or stakes, several hearths and a child's grave were uncovered. The hoe-field may be the most significant find. It is separated from the occupation layer by a sterile clay band.

Lithic artefacts
The lithic industry consists of 18,403 stone artefacts and 3702 flint artefacts, 83% and 17% respectively (see tables 6.1 and 6.2). In weight the stone artefacts dominate with 31,979.4 g compared to 2775.48 g for the flints artefacts or 92% and 8% of the weight distribution. Thus as on site S2, the flint material is clearly outnumbered by the stone artefacts, both in number as in weight.

Even more, the stone (77%) and flint (16%) artefacts both outnumber the amount of pottery (7%) (see table 6.3).

The stone assemblage is marked by a combination of grinding stones and hammerstone / anvils. The anvils, however, seem to prevail. Together with the evidence of two axes these represent a variety of activities. The high percentage of stone grit observed at the site, is also reflected in the high number of flint chips.

The larger flint artefacts show a rather regular typological distribution. The tools, dominated by scrapers and retouched blades, suggest mainly the processing of hides and plant material. The high number of tool fragments indicates the intensive use and repair of these tools. Even though in debitage material and tool preference site S4 resembles that of site S3, the use of flakes and blades and the exclusion of other types of blanks is similar to that on site S2. Even for the artefacts with visible use-wear traces the selection of blades is clear.

Site function
Site S4 seems to be the odd one out. The generally low current height of the levee, the lowest of all, is combined with archaeological features rarely encountered on the other Swifterbant sites. These are the grave of a child, the enormous amounts of grit and flint chips, and possibly the wooden stakes. Even more, pottery is present but in very low numbers compared to the other levee sites. For example, the inorganic archaeological remains are clearly dominated by the stone (78%) and flint artefacts (16%) whereas the pottery forms only 7%. The absence of clusters of white quartz and red feldspar grit suggests that this low number of potsherds is not the result of weathering of the fragments. However, the presence of pottery and the lithic debitage material and tools reveal the (somewhat) residential character of the site. The pottery suggests cooking, while the lithic artefacts show the importance of plant and possibly hide processing, presumably for food and craft purposes. Traces of wood or bone and antler working are nearly absent, and even the axes are in a highly fragmented state. In many respects, studied in this lithic research, the site largely resembles site S3, and in fact shows so many similarities that it was proposed as an annexe to site S3. Yet, it is not identical. Site S4 shares characteristics and functions with S2 and S3 combined.

It is clear to say that the hoe-field forms the first function of the site, to be continued throughout the entire occupation period, and possibly even after. However, as hoe-fields have been attested at site S2 and S3, it is possibly not a distinguishing factor. Whether the grinding tool and the nearby pot must be seen as a ritual deposition related to these hoe-fields is therefore uncertain. Additionally, a child was buried on the site. As with site S2, the combination of specific activities and a grave seems to exist. However, the lithic assemblage seems domestic in character.

6.1.5 *Swifterbant trenches S21-S24*

General aspects

These excavation trenches are located on a river dune which extends over a length of roughly 200 m, making a curve of approximately 90°, with slightly elevated ends (Price 1981). The top of the dune must have been at c. -4 m NAP while its width varies between an estimated 10 and 37 m. The excavations in the different trenches uncovered approximately 850 to 880 m². Due to the lack of a dark occupation layer the extent of the settlement area cannot be determined; neither can it be determined whether the two elevated ends of the dune form two separate sites or whether one large blanket of archaeological remains covers the whole dune surface. Trench S24, located in the peaty area between the two elevated dune tops, contained a number of flint artefacts (Price 1981) possibly supporting the second hypothesis.

The top of the river dune in trenches S21, S22, and S23 was eroded resulting in the secondary position of some of the artefacts. Trench S24 was excavated in a different way from the other three trenches without any stratigraphical information being recorded. The erosion truncated the top of the dune, erasing the A horizon and large parts of the B horizon, and covering the whole site with a thin layer of eroded sand. The features nearest to the top of the dune, like the upper parts of hearths and graves, were eroded. The complete sequence of layers was only found on the slopes of the dune (de Roever 1976).

The river dunes were inhabitable between c. 8000 and 3370 cal BC, before they also became inundated. The radiocarbon dates reveal a long occupation history at the site. Charcoal samples from different hearths place habitation between c. 6685 and 5060 cal BC. New information from charcoal samples adds later phases, roughly between 4900 - 4800 cal BC, and 4600 - 3800 cal BC. The latest phase is also characterised by a cemetery dated between c. 4550 - 3950 cal BC. This makes the graves partly older and partly contemporary with the graves at levee site S2 (c. 4250 - 4000 cal BC). Thus occupation on this river dune covers the Late Mesolithic as well as the Early and Middle Swifterbant phase.

The features and archaeological remains will briefly be discussed per trench. This is done mainly for clarity and not for revealing differences between the separate locations on the dune as this division by trench has not proved fruitful in the past, for example the relationship between the graves was not observed, nor in the present, as proven by the composition of the stone artefacts.

The recorded features in trench S21 consisted primarily of hearths, presumably even hearth pits, and five graves. Some isolated human remains were also recovered from the occupation layer, as were about forty potsherds.

The described features in trench S22 are mainly hearths and graves. The human remains include six graves and one isolated find. Grave I consists of a round pit with the remains of a skull and an associated jet pendant. This is the only grave on parcel H46 with any grave goods. With the male skeleton in the double burial of graves VII and VIII, two flint artefacts were found (see section 5.2.5 and catalogue section 2.2.6). Other archaeological remains include charcoal and c. 500 potsherds.

The majority of the features in trench S23 are again hearths, mostly containing charcoal; a few features had no or only small amounts of charcoal and were interpreted as pits. Price (1981) observed that all features are shallow which is (partly) the result of the erosion. The human remains were limited to a single grave. The archaeological remains comprise fragments of bone and a few dozen potsherds.

The different excavation technique in the small test trench of S24 resulted in a limited amount of information. Flint artefacts are the only finds reported for this trench.

Lithic artefacts

The lithic assemblage at parcel H46 possibly only includes the artefacts from the excavations and not from the ditch slope inspections at trenches S21 and S22 (see sections 2.7.7 and 2.7.8). In total, 1065 stone artefacts and 19,311 flint artefacts were uncovered (see tables 6.1 and 6.2). The stone artefacts are clearly outnumbered by the flint artefacts (5% versus 95%). The stone artefacts have a total weight of 16,351.7 g, while the flints weigh 42,153.60 g (28% versus 72%).

When the pottery is included, the inorganic archaeological remains at the site are clearly dominated by flint (91%). Stone artefacts (5%) and potsherds (3%) are present in roughly the same amounts (see table 6.3).

Most of the stone artefacts are most likely of Neolithic date. Their characteristics clearly fit in with the material from the levee sites. Then again, the exceptional find of the two fitting fragments of a mace-head, are of a Late Mesolithic date as proven by the radiocarbon date from the pit containing one of the fragments (see Drenth & Niekus 2008, 2010).

The flint material, on the other hand, is largely of Late Mesolithic date. The typical small size and fine debitage technique was often observed, combined with a wide range of microliths. Another smaller admixture is certain to be Neolithic. Several artefacts are identical to the material found on the levee sites. Yet, as the flint material from both phases have overlapping characteristics, the un-diagnostic finds are hard to separate between the Late Mesolithic and the Middle Swifterbant phase.

Site function

Price (1981: 99-102) observed that in trench S23 the vertical distribution suggested at least two stages in the deposition of the artefacts. He consequently suggested an aceramic Mesolithic occupation before 4800 BC, and a ceramic occupation starting around 4300 BC. He also observed that the graves in trench S22 were probably dug after the last occupation phase of the site, for example during the Neolithic habitation of the levee sites. This largely proved to be true. The Mesolithic radiocarbon dates, along with the typical Late Mesolithic flint artefacts, put most of the occupation in this time frame. The Neolithic presence is attested by graves, certain lithic artefacts, and pottery. This pottery has Swifterbant characteristics and is typologically placed in the middle phase. The 2008 coring campaign yielded charcoal at various depths in the surrounding clay sediments (Geuverink et al. 2009, Raemaekers & Geuverink 2009). The depth of these finds was subsequently related to a regional sea level curve (van der Plassche et al. 2005). This analysis suggested that the river dune was also occupied in the Early Swifterbant phase. Nevertheless, no typical pottery is known from the excavations (Raemaekers 2011a and b). Nor did the flint or stone artefacts reveal clear evidence of this occupation phase.

The Mesolithic phase is characterised by debitage material and typical tool types like microliths. Some of the scrapers, borers, and retouched pieces must belong to this phase as well. This combination of artefact categories indicates a wide variety of activities at the site. However, it is impossible to pronounce upon the character of this occupation. It may be a collection of several settlement phases, with or without special activity sites.

The limited number of clearly Neolithic tools and debitage material, in combination with the cemetery and low amounts of pottery, suggests a low residential character of site. One of the working hypotheses is that the river dune is some sort of stone cache or depot as waste forms the largest artefact category and stone tools are very rare. This site is indeed the closest to the Vecht system that ultimately leads to the boulder clay deposits. After arriving from a procurement trip, the material may have been dropped off at the river dune. From there on it could be distributed to the other sites of the Swifterbant cluster when needed. The presence of bipolar pieces and regular blades with use-wear traces points to at least some isolated activity events.

6.1.6 Swifterbant site S41

General aspects

This levee site is located farther south along the tributary which runs past sites S3 and S4. As no excavations have been conducted at this site, little is known of the occupation layer or the function of the site. The coring campaign of 1977 revealed a cultural layer extending over at least 375 m^2 with a thickness of c. 20 cm. The only archaeological remains that have been gathered derived from the stratigraphical inspection of the ditch slope sections. Apparently, the cultural layer extended over both sides of the ditch.

The lack of excavations, or any other form of detailed research, results in the absence of radiocarbon dates. Yet, the geological composition of the site is similar to the other levee sites implying that habitation must have taken place between c. 4360 cal BC and 3800 / 3700 cal BC. The cultural designation of the site is also hindered by this absence of radiocarbon dates and the rarity of diagnostic find material. By analogy with the other levee sites in the vicinity, and the similarity between the lithic finds, one may conclude that the site was occupied in the middle Swifterbant phase.

Lithic artefacts

The only archaeological material available and analysed in this research is the stone and flint artefacts. These comprise three stone artefacts weighing 237.6 g and 59 flint artefacts weighing 416.57 g. Charcoal and bone fragments, or any other material, may have been collected during the ditch slope inspections but as none of this is published, it is uncertain whether it was recovered, and if so, kept.

Site function

The absence of excavations and the very limited number of archaeological remains makes it impossible to pronounce upon the seasonality or duration of the occupation. The lithic finds might hint at the function of the site, or at least the presumed activities present at the site. Still, the exact nature can wildly be debated upon as it is unknown which material is missing. When the lithic artefacts are compared to the lithic assemblages from the different sites the composition measures up to that of sites S2, S3, S4, S51, and partly even trenches S21-S24. Which one it is most similar to cannot be discerned without further analyses and excavations. However, the refit between the axe fragment of site S41 and S3 at least suggests contact between the two sites, and possibly implies contemporaneous occupation.

6.1.7 Swifterbant site S51

General aspects

This is the second levee site at the main creek in the Swifterbant area; it is located farther downstream from site S2, also in an isolated position. The location consists of four small dark coloured occupation zones in an area of approximately 80x10 m and two more peripheral areas (see sections 2.5.3. and 2.7.14). The main creek eroded large parts of the occupation layer making it unclear how many sites originally must have been there or how far they extended. The only excavation was conducted in 1978 and covers two core regions in one peripheral area. The cultural layer exposed in the trench was c. 20 cm thick. In total c. 120 m^2 was excavated, which is roughly 53% of what is currently known of the area.

Again, no radiocarbon dates are available. Fortunately, the excavations uncovered a fair amount of pottery facilitating the cultural designation to the Middle Swifterbant phase. Also the general 'life span' of the levee sites support this definition.

The features and archaeological remains are rather limited as only a small strip of cultural layer remained in situ. Two features were revealed; one was defined as a hearth, the other may have been some sort of pit containing a bone axe, a wooden shaft, and four lithic artefacts. The archaeological remains include these organic tools, the lithic artefacts mentioned below, and c. 1270 potsherds. Again, the pottery is very similar to that of site S3 (de Roever 2004: 60).

Lithic artefacts
The lithic industry includes 292 stone artefacts and 217 flint artefacts (see tables 6.1 and 6.2). This results in a slight numerical dominance of 57% over 43% of the material. The weight is more dispersed, the stone assemblage weighs 4964.4 g and the flint assemblage only weighs 235.57 g, which is 95% and 5% of the weight distribution.

The distribution of the inorganic finds is, however, dominated by the pottery. The potsherds form 71% of the remains, whereas the stone (17%) and flint (12%) artefacts are represented by far less material (see table 6.3). Even so, the lithic remains reflect what is to be expected from the levee sites.

The stone assemblage is especially characterised by smaller fragments. With the few tools a wide variety of activities may be performed as mainly grinding functions are combined with anvils, hammerstones, and even a remarkably shaped axe fragment.

With the flint artefacts the tools are represented by a relatively high number. They are clearly dominated by scrapers combined with a slight supremacy of retouched blades over all the other tool types. Large regular blades with visible use-wear traces were selected for certain activities such as plant processing, possibly both for food production and crafts purposes. Other activities may have been hide processing and maybe even the processing of wood and bone since tools of such raw materials have been found at the site.

Site function
Site S51 has a clearly isolated position, which it shares with site S2. In lithic artefact composition the site is similar to the other levee sites, suggesting a similar use of the site, yet resembles site S2 the most. The dominance of scrapers and of blades with clear use-wear traces of plant processing indicates the importance of certain specific activities at the site. The absence of rejuvenation pieces and ornaments, which occur on all other sites, indicate the scarcity of certain components of the lithic industry, limiting the representativeness of the remaining material. Possibly this absence of certain categories of lithic material may rather be explained by the eroded character of the site than by the absence of certain activities.

6.1.8 Swifterbant site S61

General aspects
This river dune site is the most southern occupation area currently known at Swifterbant. The only excavation was conducted in 1978 revealing an area of 5x15 m, which is only 2% of the whole river dune. The little information we have comes from de Roever (2004). As with site S41, it is unclear exactly what was found at the site.

The three available radiocarbon dates come from charcoal samples. These cover a rather large time frame ranging between 5310 and 5060 cal BC on one hand, and between 4500 and 3800 cal BC on the other. Along with the presence of Mesolithic artefacts such as a microlith and Neolithic pottery the site must have been inhabited in different phases from the Late Mesolithic to the Middle Swifterbant phase.

The information on the archaeological remains is limited to that of lithic artefacts and pottery. A very small number of bone fragments was recovered while charcoal fragments must have been present as well. The potsherds, nearly 200, were all recovered from the higher levels of the stratigraphy.

Lithic artefacts
The lithic industry is a combination of 2564 stone artefacts and 1837 flint artefacts (see tables 6.1 and 6.2). This is 58% and 42% correspondingly of the lithic artefacts retrieved from the site. The weight distribution is similarly dispersed, 2839.5 g or 58% for the stones and 2083.89 g or 42% for the flints. Thus the stone artefacts slightly outnumber the flint artefacts, both in number and weight.

The potsherds form 4% of the inorganic remains, whereas the flint artefacts form 40% of the material and the stone artefacts the remaining 56% (see table 6.3).

The stone assemblage is overwhelmingly made up of grit (99%). The few larger artefacts are mainly debitage material. The two tools and the ornament closely fit in with the material of the levee sites. They are therefore likely to be of Neolithic age.

The flint assemblage also shows high numbers of chips and debitage material, presumably most of Mesolithic age. The admixture of Neolithic flint artefacts may be assumed from several artefact types. More remarkable is the low amount of tools and total absence of scrapers, a tool type so common on all the other sites, both levee and river dune. Alternatively, retouched pieces occur predominantly. Another inconsistency is a total absence of blades with visible use-wear traces and the low percentage of heat exposed artefacts.

Site function
The limited amount of archaeological information available for this site hampers the functional interpretation. The large number of lithic artefacts < 3 g and < 1 cm is indeed overwhelming, but its significance is not fully understood. Whether it is a postdepositional process affecting both raw material types of, largely, different periods in time, or whether it is the result of two separate site functions, i.e. flint debitage and stone temper production, is unclear. The large amount of debitage material and chips would indeed imply such a function of the site whereas the stone artefacts suggest a wider range of different activities during the Neolithic.

6.1.9 Swifterbant sites S80-S84

General aspects
The long river dune covering parcels G20 up to H4 has at least four and maybe five or even six sites. The difficulty in interpreting these remains is described in detail in section 2.7.17. In 1959 some Bell Beaker material was uncovered presumably at parcel H4, designated with site S80 in this study. In 1993 archaeological research was conducted at parcel H2 confirming Swifterbant presence at that site. Finally, an excavation and coring campaign in 2002 revealed flint material and archaeological indicators, including charcoal, on parcels G20, H1, and H2. These three sites are designated S84, S83, and S82 respectively.

The Bell Beaker pottery and the flint artefacts on H4, found in an eroded sand layer, indicate (nearby) occupation during the Late Neolithic. As on site S2 (Raemaekers & Hogestijn 2008), this material was no longer in situ making it unclear where it originally came from. Sites S2 and S80 are after all located more than 2 km apart. The pottery found in the 1993 campaign confirms occupation during the Swifterbant phase. The flint material uncovered during the 2002 excavation campaign reveals microliths dating the occupation of the dune at parcel H1 to the Mesolithic. The same applies to the three radiocarbon dates of the charcoal samples. These date between 5370 and 4990 cal BC.

Not much archaeological material remains today of research conducted at these sites. The question remains whether Van der Heide did only find pottery and flint, or whether other remains, such as charcoal and burnt bone fragments, have been lost or were not stored in the first place. At least charcoal and wood samples from two different campaigns were stored.

Lithic artefacts
The lithic material from these sites is limited as the research was limited as well. The stone material consists of two artefacts < 3 g, whereas the flint material is more abundant with 233 artefacts (1% versus 99%). Most of the flint material from sites S80-S84 has technical and typological similarities with site S61. This implies the generally Mesolithic age of the flint material. The presence of some regular blades at least suggests Neolithic occupation.

Site function
The distribution of the flint material over the different artefact categories resembles levee sites S3 and S4 the most, suggesting a more domestic or residential use of the sites when compared to S61. It has been addressed before, the limited amount of artefacts per site necessitated the accumulation of the material of sites S80-S84. Therefore, it may not be ruled out that this sketched image is a compilation of sites with different functions. Even though only a limited amount of material was collected, it seems that sites S80-S84 possibly have the lowest admixture of Neolithic material.

6.1.10 A comparison of the Swifterbant sites
The lithic industry at Swifterbant is characterised by two essential components. The flint assemblage is combined with large amounts of stone debitage and tools to perform all sorts of different tasks of everyday life. It may be clear that both are part of one integrated system of lithic artefacts and tools to be used every day. The performed activities are not limited to stone / flint knapping and food production but cover a wide range of different plant processing techniques, for food production and all sorts of crafts, but also hide, bone, antler, and wood working, possibly also the polishing of axes, combined with other activities such as ornament and temper production.

The stone tools are composed largely of grinding stones, anvils, and hammerstones, and all sorts of combinations thereof. Polished axes also occur at the different sites. Another aspect of the stone industry is the rather large amount of stone flakes. Together with the cores these may be interpreted as debitage material for the production of tool's blanks, but as hardly any have been transformed into tools they are likely to have been used unaltered.

The flint tools are a combination of retouched pieces, scrapers, rounded pieces, and borers. The numerical dominance of the artefacts with visible use-wear traces, i.e. most often blades with traces of siliceous plant material, may be the result of ease by which these traces are created. Van Gijn (1990, 2010) stated that these traces develop rather quickly, possibly quicker than traces of other contact materials. In this way, the importance of plant processing may be overestimated. The arrowheads are an exclusive combination of trapezes and transverse arrowheads. The final tool type is smaller fragments of polished flint axe. The blanks for all these tools were mainly produced on the sites themselves[3], only the large, regular blades used for certain tool types, and possibly certain activities, were produced somewhere else and brought to the sites. The latter appear to be the result of some specialised technique, possibly used by skilled flint knappers, whereas the flint debitage at the sites is more varied and could presumably have been produced by anyone.

The main residential site at Swifterbant is without a doubt site S3. Both stone and flint artefacts point to the residential character of the site; the house confirms the use as a settlement site or base camp. The rebuilding of the house indicates different occupation phases and suggests the long occupation history and the continued importance of the site. The same accounts for the clay floor hearths, which were reconstructed regularly.

The inorganic material mainly consists of flint artefacts combined with pottery and stone artefacts. The high percentage of debitage material over tools, both with the stone and the flint assemblages, suggests a residential use of the site; tools were produced and probably taken to other sites to be used there. At the same time, the diversity of the stone tools suggests a wide variety of activities performed at the site, even if it was in limited amounts. The presence of flint scrapers, and retouched flakes and blades also points to all sorts of everyday activities, and possibly indicate the importance of hide working. All these tools were produced, and possibly repaired, at the site whereas the import and use of large, regular blades is limited. Thus, site S3 is not only characterised by a housing area but also by a diverse assortment of activities ranging from animal and plant processing for food production and crafts, over temper and ornament production, to bone, antler and wood working.

Within the stone and flint assemblages the similarities between S4 and S3 may also be observed, just as some characteristics are clearly different. The amount of debitage material and tool preference is similar, whereas the large amount of grit and chips, and the specific selection of certain types of blanks for the tools tend to the characteristics seen on site S2. As the activities performed with lithic tools are similar but less varied than on site S3, in combination with several distinct other functions present at the site, S4 resembles site S3, yet is not identical. Site S4 may be interpreted as an annexe of S3 where similar activities, yet not identical activities, were performed as suggested by the differences in toolkit. Based on the lithic evidence, I tentatively would suggest site S4 may even be an extensional area where a selection of activities were performed, while site S3 was the residence which would be returned to at night but was also used for other, specific activities and tasks.

If this information is combined with the results of the soil analysis by thin sections (Huisman et al. 2009) the idea of site S4 being an annexe to site S3 is confirmed. Even more, it is postulated that both areas originally formed one site, and that the creek dividing the two areas developed at a later stage. The lithic analysis therefore gives proof of the different activity areas on the original site as the material from site S4 is slightly different from that of site S3. Additionally, the amount of pottery at site S4 (1626 or 7%) is significantly lower than at site S3 (c. 20,000 or 36%).[4]

Both sites S2 and S51 have an isolated position in the creek system. Their lithic assemblages differ in typological composition and proportion from those of sites S3 and S4, yet resemble each other the most. Site S3 shows a dominance of debitage material and bipolar pieces in combination with a low tool count and artefacts with visible use-wear traces while sites S2 and S51 have the opposite. The number of regular blades is high for sites S2 and S51, and much lower for sites S3 and S4. As site S51 was partly eroded, the representativeness of the material and its similarity to that of site S2 remains speculative. For example, site S51 is characterised by the highest percentage of scrapers as well as the highest level of blades with visible use-wear traces suggesting the site was used for 'two specific activities', i.e. hide working and plant processing.

It therefore appears that sites S2 and S51 were special activity sites, focussed on the use of grinding stones in combination with regular blades or scrapers, instead of settlement sites. The large amount of pottery, in comparison to that of stone and flint, on sites S2 and S51 (61% and 71%) is another difference. The combination of a grinding stone with pottery was already observed on site S4 (see section 4.2.4, catalogue section 1.2.4). Would it be too far-fetched to see a relationship between grinding stones, processing cereal, pottery, and regular blades used for plant processing?

It may be noted that animal bones at site S2 are less abundant when compared to the other find categories such as pottery or lithic artefacts. Even the amount of plant remains or charred seeds is far less compared to site S3. Alternatively, the better preservation conditions at the latter site, in combination with the clay hearths,

3 With the exception of polished axes.

4 The issue of comparing the amount of pottery, stone and flint artefacts with each other is a very tricky matter. It may be argued that working with a weight based classification would be better given that working with amounts may be seen as rather subjective. For example, pottery might be more sensitive to fragmentation, or the classification system of de Roever and Raemaekers may be different – did they both include the smallest pieces of pottery or was some discarded -, was the high number of small pieces of grit and chips at site S4 also observed for the pottery, and so on. On the other hand, the high specific weight of stone artefacts possibly results in a distorted view as the differences in weight between the flint and the pottery will be minimal.

would have resulted in larger amounts of charred and uncharred food remains.

The cemetery at site S2 clearly signifies a function not present at site S3[5]. However, this is a function it shares with site S4, even if it is in minor degrees. The isolated position of site S2 may have made it the ideal candidate for such a function. The same applies to trenches S21-S24 and site S51. The question remains however, whether a cemetery was ever present at site S51. We must also keep in mind that the contemporaneity between the lithic material and the cemetery at site S2 could only partially be corroborated.

The remaining levee sites, such as S31 and sites S41-S43, must have formed an intrinsic part of the site territory as well. This is established by the flint and stone material from site S41 which is in full conformity with what is found on the other levee sites. The refit between an axe fragment of site S41 and S3 supports this point.

The river dunes show traces of occupation at the same time of the levee sites (c. 4300 – 4000 cal BC). Most likely, 'site' S21-S24 was used more intensely than sites S61 and S80-S84. The presence of a cemetery at the former points to this, as well as the amount of stone artefacts and the composition of the flint assemblage. Even if it is hard to separate the Mesolithic from the Neolithic artefacts, the larger part of the flint material can be defined as Mesolithic, while some of the other artefacts have characteristics that clearly fit in with the material from the levee sites. Even differences in debitage technique and raw material usage have been observed. At the same time, most of the stone artefacts at site S21-S24 are believed to be of Neolithic date, even if they differ from the levee sites in certain characteristics and typological composition. It is therefore believed that the river dune sites were also used as an intrinsic part of the site territory during the Middle Swifterbant phase, yet maybe to a lesser degree or for different activities than the levee sites.

6.2 Presentation of the other Swifterbant sites

6.2.1 Introduction

Many different Swifterbant sites are spread over larger parts of the Netherlands and the neighbouring parts of Belgium and Germany. All these sites have been excavated in various decades with different techniques and are located in diverse geomorphological settings. Some are large settlement sites, others are small special activity camps, but all are characterised by varying amounts of Swifterbant pottery.

In the following section only the Swifterbant sites significant to this research will be discussed chronologically. The selection of suitable sites is first and foremost based on the presence of flint and stone artefacts. The total lack of lithic artefacts is the most pertinent and obvious reason not to include a site in this research. Although the sites could provide general information on site diversity, site functionality and site location, several of the most specific questions in this research will not be able to be answered. Five Swifterbant sites are therefore not integrated in this research. The first one is Ede-Rietkamp (Hulst 1993) dated between 5220 and 4720 cal BC. The presence of polished pottery was attested. A second Early Swifterbant site that revealed no lithic artefacts is Bronneger (Kroezenga et al. 1991). This site, dated between 4770 and 4610 cal BC, is known for the ritual deposition of a Swifterbant pottery vessel in association with two red deer antlers in a peat context. At the site of Zoelen-Buren (Hogestijn & Lauwerier 1992, Hulst et al. 1993) the discovery of a burial site must be mentioned. As this is a rare feature at Swifterbant sites it is unfortunate that none of the graves yielded any grave goods, or any other ornaments, as this would have given additional information for this research. Finally, very little information exists on sites Schiedam (Modderman 1955) and Winterswijk (Schut 1984), but neither is known to have produced flint or stone artefacts.

Other issues like the quality of the site, i.e. its stratigraphical integrity, the quality of the find circumstances, the preservation and amount of archaeological remains, the small size of the excavation and the statistical relevance of a small amount of archaeological material, the availability of radiocarbon dates, and the accessibility of the data as a result of substandard publications, justify a further elimination of low value locations. The sites that are dismissed for one, or more, of these issues are Bergschenhoek, Hüde I, Melsele-Hof ten Damme, Meppel-De Gaste, Nagele-J112, Schokland-P14, Wetsingermaar, and Zeewolde[6] (Lanting & Mook 1977: 57, Raemaekers 2005: 269)[7]. The site Bazel-Sluis was excavated in 2011 and only a few research results have been published (Perdaen et al. 2011). Finally, Schokkerhaven-E170 / 171 is a borderline case and a potentially good site. Although the stratigraphy of the site is complex, the only undisturbed late Swifterbant context is claimed for Schokkerhaven I (Hogestijn 1990, 1991).

5 More differences between sites S2 and S3 could be cited, yet the question remains whether these have anything to do with the different use of the sites (see section 6.3.10).

6 Relevant publications are Bergschenhoek (Sarfatij 1977, 1978, Louwe Kooijmans 1985, 1987), Hüde I (Deichmüller 1964, 1965a, 1965b, 1968, 1969, Kampffmeyer 1991, Stapel 1991), Melsele "Hof ten Damme" (van Berg et al. 1992), Meppel-De Gaste (van der Waals 1972), Nagele-J112 (Hogestijn 1991, Ten Anscher 2012), Wetsingermaar (Feiken et al. 2000, Raemaekers et al. 2011/2012), and Schokkerhaven (Hogestijn 1990, 1991).

7 The dating discrepancies of sites Schokkerhaven-E170/171, Schokland-P14, and Hüde I are thoroughly discussed in Lanting & Van der Plicht (1999/2000).

The main problem is, however, the very limited amount of information published in those two articles.

This leads to the main issue, which is currently hard to resolve, namely the absence of a well-documented reference site for the late phase of the Swifterbant culture. As long as this matter is unresolved, the problematic nature of several of the Late Swifterbant sites will remain. Their number is limited and they should therefore be used to their full extent and potential. Unfortunately, most of them are currently of no use to this research.

Another of the central concerns is the long occupation history of most of these sites. The archaeological remains, and especially the flint and stone artefacts, from the many different occupation phases are hard to allocate to a specific phase or culture, for example whether they belong to the Late Swifterbant or the Early TRB phase, just because of this lack of a well-documented reference site. The reasons for dismissal stated above also apply to a certain degree to Emmeloord-J97 and Urk-E4. If these sites were to be dismissed as well, no reference material of the Late Swifterbant phase would be at hand to conclude this research. Therefore, these two sites are included in a general way.

Other sites are rejected because the cultural designation of the ceramic finds to the Swifterbant culture is contested. Raemaekers (1999: 92) mentions Spoolde, Heems/Hardenberg, and Zwolle-Groenlo of which the Swifterbant affinities are dismissible. Lanting & Van der Plicht (1999/2000: 25-26) describe the latter two and Weerdinge/Oude Asbroeken as sites "with (possibly) Swifterbant pottery". None of these will be considered here, nor will there be given much detail on the other sites; the relevant publications are listed for consultation.

Several of the sites that are addressed below have multiple occupation phases ranging from the Late Palaeolithic to the Middle Neolithic or even Middle Bronze Age. Although all phases are briefly reviewed, only the flint and stone artefacts from the occupation phases relevant to this study will be thoroughly discussed in the following sections.

6.2.2 Hardinxveld-Giessendam, Polderweg

General aspects

One of the earliest finds attributed to the Swifterbant culture is the site at Polderweg (Louwe Kooijmans 2001a, Raemaekers 1999). Together with Hardinxveld-Giessendam De Bruin, it forms a twin site. Both sites were part of the Betuwe Project and are published in detail (see Louwe Kooijmans 2001a and 2001b). The settlement of Polderweg is located on the top of a Pleistocene river dune in the intercoastal plain of the Rhine and Meuse delta. The river dune was rather small, 80x50 m, yet clearly visible because of its elevated position in the landscape. The different vegetation must also have made it stand out. The top of the dune was covered with deciduous trees offering shelter from the wind to the settlement located on the slopes of the dune. The area around the site was at all times a wetland area with backswamps making it impossible to journey through by dry land. The settlement, however, was easily accessible by canoe as the open water came up to the dune body.

Three phases are recognised by radiocarbon dating and stratigraphy combined with the sea level curve. It was originally thought that phase 1 started at 5400 cal BC, phase 1/2 at 5100 cal BC, and phase 2 at 5000 cal BC. Habitation ended at 4700 cal BC, whereas the site disappeared below the delta peat and clay around 4600 cal BC (Louwe Kooijmans 1999: 116). Recent research adjusted the time frame for phases 1 and 2 (Mol & van Zijverden 2007: 96). Nowadays phase 1 is dated between 5430 and 5350 cal BC, while phase 2 is between 5200 and 5070 cal BC. Either way, both phases 1 and 1/2 are situated at the end of the Late Mesolithic. Only phase 2 is dated to the early phase of the Swifterbant culture. The cultural designation is based on the presence of the typical forms of pottery. Due to the absence of bones of domestic animals or remains of cultivated plants, Polderweg can be interpreted as 'ceramic Mesolithic'. The rapid succession of the three phases indicates a continuous occupation of the Lower Rhine and Meuse Basin outside the loess area (Louwe Kooijmans 2001a).

The archaeological remains do not limit themselves to pottery and lithic artefacts. Tools made from bone and antler such as antler and bone axes in a wide range of forms, bone awls and chisels, beaver and boar teeth chisels, but also a wooden bow, hafts, paddles, spears, fragments of a canoe and wooden poles and stakes were retrieved; even pieces of bast rope were preserved (Louwe Kooijmans 2001a). Several human and dog burials are present at the site, as well as isolated human skeletal remains. Bones of wild mammals, birds, fish and even reptiles were recovered. It must be mentioned that most of the material comes from the Mesolithic inhabitation phases, phases 1 and 1/2.

Lithic artefacts

That the majority of the archaeological remains comes from the Mesolithic occupation phases also applies to the flint and stone artefacts (table 6.4). Only 1% of the flint material (n: 192) and 1.6% of the stone material (n: 1) analysed was retrieved from the Swifterbant layer. It is this material that is discussed here. It must be mentioned that raw material determination as well as heat exposure of the flint artefacts was performed for only a part of the flint assemblage (45%) and that the boundary between smaller and larger artefacts is 5 mm in length.

Table 6.4 Total number of flint and stone artefacts at Polderweg.

Flint	Amount		Weight (g)	
Phase 0	52	0.3%	84	0.3%
Phase 1	17640	93.1%	22642	88.6%
Phase 1/2	1052	5.6%	2025	7.9%
Phase 2	192	1.0%	786	3.1%
Undetermined	2	0.0%	10	0.0%
Total	18938	100%	25547	100%

Stone *	Amount		Weight (g)	
Phase 0	1	1.6%	51	0.2%
Phase 1	58	92.1%	30969	97.9%
Phase 1/2	3	4.8%	562	1.8%
Phase 2	1	1.6%	68	0.2%
Total	63	100%	31649	100%

* The large amounts of naturally occurring gravel are not included.

Most of the analysed flint material could not be defined by type (69%). The ones that could be classified are largely made up of coastal flint or Meuse eggs[8] (17%), less often of Rijckholt flint (9%) or terrace flint (5%). The latter may be gathered in the Meuse valley or from the Meuse deposits in the middle of the Netherlands. Meuse eggs or coastal flint[9] may also be gathered at the coast. Wommersom quartzite[10] and northern flint, found in the pre-Swifterbant Mesolithic layers[11], were no longer used in phase 2 at Polderweg. Of the analysed flint 13% was visibly exposed to heat. The debitage focussed on the production of flakes; blades were used to a lesser extent (table 6.5). Cores, rejuvenation pieces, and splinters point towards production on the site. Cortex is present on approximately 50% of the larger artefacts which is largely influenced by the small dimensions of the nodules. Anterior patina occurs rarely (4%). The tools are defined as one scraper, nine retouched flakes, one retouched rejuvenation flake and two indeterminate tool fragments. Use-wear analysis mainly showed traces of plant processing, bone and antler processing occurs less, and hide working appears only once. Some of the tools were even hafted (van Gijn et al. 2001a: 154).

Table 6.5 Total number of artefacts per typological category of the site Polderweg.

	Number	%	% >
Debitage material	**73**	**38%**	**53%**
Flakes	40	20%	29%
Blades	11	6%	8%
Rejuvenation pieces	11	6%	8%
Cores	11	6%	8%
Tools	**13**	**7%**	**9%**
Scrapers	1		1%
Borers			
Burins			
Microburin			
Combination tool			
Microliths			
Arrowhead			
Trapezes			
Transverse arrowheads			
Tools on flake	9		6%
Tools on blade			
Tools on other blanks	1		1%
Indet. tools			
Indet. tool fragments	2		1%
Splintered pieces			
Waste	**53**	**27%**	**38%**
Subtotal ≥ 1 cm	***139***	***72%***	***100%***
< 1 cm	**53**	**28%**	
Total	**192**		

Of the generally low number of stone artefacts[12], only one was attributed to the Swifterbant phase. It is a quartzite stone without any traces of any kind. In conformity with the other stone artefacts, this stone was presumably gathered in the Meuse basin (van Gijn et al. 2001c).

Thus, the lithic industry largely consists of flint artefacts (99%) with hardly any stone artefacts (1%). When all inorganic archaeological remains are taken into account, the dominance of the flint artefacts (71.1%) over the pottery[13] (28.5%) is as nothing against the small percentage of stone artefacts (0.4%) retrieved at the site.

8 Some of these Meuse eggs were 'opened' by using the bipolar technique.

9 The term coastal flint for this type of small nodules may be ill-chosen. They originate from Tertiary (Miocene) deposits which are, in southern Limburg, exposed in the Meuse Basin (van Gijn et al. 2001a: 128). Therefore, they can be gathered from Meuse deposits where they occur in secondary contexts and do not need to be gathered at the coast. Their Dutch name *Maaseitjes*, translated as 'Meuse eggs', is thus more appropriate.

10 As Wommersom quartzite is used in the same way as flint, both are by many researchers bracketed together.

11 It must be mentioned that the number of these artefacts is very low. Wommersom quartzite and northern flint are represented by eight and two artefacts respectively.

12 Besides large amounts of naturally occurring gravel, only 63 artefacts weighing more than 5 g were found at the site (van Gijn & Houkes 2001: 164).

13 After refitting, 77 potsherds were attributed to phase 2. These have a combined weight of approximately 1600 g (Raemaekers 2001a: 105-106).

Site function
The site was a temporary or semi-annual settlement, occupied in winter between September and March, in a system with limited residential mobility (Louwe Kooijmans 2001a: 455, 464). The function as base camp is confirmed by all sorts of archaeological finds and features. The presence of lithic artefacts and pottery, along with all sorts of bone and antler tools, form a wide toolkit for performing all sorts of activities. Production waste of these tools proves that they were manufactured at the site entailing extended stays at the site. Use-wear traces point to hide working and the processing of plant material for the fabrication of fishing nets and baskets (Louwe Kooijmans et al. 2001: 324). Features indicate the presence of huts made out of wooden posts with dug out floors.

Conclusion
The site of Polderweg is very similar to the Swifterbant cluster, especially site S3. Habitation occurred in a landscape that was nearly identical; the Pleistocene river dunes of the Vecht and palaeo-IJssel basin were also only accessible by water and must have been clearly visible from the open water and the landscape in general. The accessibility of Swifterbant trench S25, revealed by the trample zone between the dune top and the water, is in that respect very similar. And although no canoes have been found in Swifterbant, their occurrence is just as certain as those present in Polderweg, De Bruin, and Bergschenhoek. The area must have been a good hunting ground for otters, beavers and pike as plenty of bone remains suggest. The extensive presence of plant polish on the flint tools at Polderweg is related to the diverse fishing and hunting activities (van Gijn et al. 2001a), just as it is related to the production of (fyke) traps and (fishing) nets for which plant material needed to be processed. It has been attested that the regular blades of Swifterbant site S3 have the same extensive frequency of plant polish implying similar activities at both settlements. However, hide processing is nearly absent at Polderweg.

On the site of Polderweg bone chisels along with boar and beaver teeth were used for finer woodworking. At Swifterbant wild boar teeth were used as pendants and were apparently no longer used as chisels. Woodworking is indirectly proven by axes, beaver teeth and stone flakes (see sections 4.8.2 and 4.8.3). Unfortunately, the beaver teeth at Swifterbant show no direct traces of use to the naked eye, whereas the specimens of Polderweg are clearly altered.

Contrary to the Swifterbant sites, the raw material procurement sites are all located to the south of the site and much farther away. Both the Meuse valley and the Meuse deposits in general were preferred. These provenance areas are located between 125 km and 150 km from the settlement. Wommersom quartzite, so often used in Late Mesolithic contexts, is absent in the Swifterbant occupation phase of Polderweg, just as it is absent at Swifterbant. Yet, as it is present at De Bruin it may not be significant at all. The same accounts for the near absence of stone artefacts.

As the number of flint and stone artefacts from phase 2 at Polderweg is very limited, the material is largely Late Mesolithic, the resemblance to Swifterbant trenches S21-S24 is striking. Even more, the low number of scrapers and the high number of retouched pieces is in accordance with another river dunes site, namely site S61.

6.2.3 Hardinxveld-Giessendam, De Bruin

General aspects
The river dune site De Bruin, is located approximately 1 km to the southwest of Polderweg in an identical environmental setting. Although the river dune is larger and higher than its neighbour, approximately 0.5 hectare and 1.5 m high at c. 5000 cal BC, the inhabited area was smaller (20x40m in phase 2 and 25x25m in phase 3). This second large scale excavation has also been published in detail (see Louwe Kooijmans 2001b).

As with Polderweg, three phases have been distinguished, yet their duration and especially their time of abandonment is remarkably different. New research re-adjusts the dates of the different occupation phases (Mol & van Zijverden 2007: 97)[14], just as at Polderweg. Phase 1 is now dated between 5230 and 5110 cal BC and is aceramic. After a hiatus[15], the second phase starts at 5040 cal BC and ends at 4940 cal BC. The presence of pottery at this stage is attested while subsistence is still non agrarian. Finally after a period of peat build-up, to be interpreted as a second hiatus, phase 3 is dated between 4560 and 4480 cal BC (Louwe Kooijmans 2001b: 73, 503, Mol & van Zijverden 2007: 97). This time habitation is characterised by pottery and small scale animal husbandry. The site was covered by peat and clay from approximately 4200 cal BC onwards (Louwe Kooijmans 1999: 116). It was observed that the sedimentary layers are not as well separated as on Polderweg, so some contamination may have occurred between the different phases (Louwe Kooijmans 2001b: 73, 503). The cultural designation of phase 1 is Late Mesolithic, while phases 2 and 3 relate to the Early Swifterbant period.

The archaeological remains are again very rich in organic finds. Besides pottery and lithic artefacts, tools are made from bone and antler. The types are very similar to those

14 The old dates are 5500 - 5100 cal BC (phase 1), 5100 - 4800 cal BC (phase 2), and 4700 - 4450 cal BC (phase 3) (Louwe Kooijmans 2001b: 73, 503).

15 In the publication Louwe Kooijmans states that the three phases are not separated by archaeological sterile layers or clear hiatuses, but by layers with a relatively low number of finds. In his opinion, the hiatuses in the radiocarbon dates may be interpreted as periods of low occupation intensity (Louwe Kooijmans 2001b: 503).

of Polderweg and include antler and bone axes, bone awls and chisels, and beaver and boar teeth chisels. Two red deer teeth are characterised by a perforation implying their use as pendant or amulet. The wooden artefacts also include fragments of a bow, hafts, paddles, spears, fragments of canoes and wooden poles and stakes. Most spectacular is the discovery of a complete canoe c. 5.5 m long attributed to the first phase. A fish trap, presumably belonging to phase 2, was recovered as well. As at Polderweg, several human burials and isolated human skeletal remains were found (phase 1), and numerous bones of wild and domesticated mammals (phase 3), birds, fish and even reptiles. During phase 3, several deposits of pottery and domesticated animals may point towards changing votive or cultural practices.

Lithic artefacts

Most of the archaeological remains were found in phase 2 layers (table 6.6). The flint and stone artefacts comprise 88.1% and 88.4% of the material found at the site. As the first phase is dated to the Late Mesolithic, these finds are not discussed here. Phase 3 incorporates the remaining 8.7% of flint artefacts and 10.3% of stone artefacts. The Neolithic flint and stone artefacts will be presented per phase. As with the material from Polderweg, only a selection of the assemblage was analysed in full detail (c. 55% to 57%). Furthermore, the divisions used in the flint analysis by van Gijn needed to be recalculated to fit in with the categories and definitions used in this research. Therefore, the percentages in this publication slightly differ from those in van Gijn's publication. A fundamentally different approach could not be recalculated, that is the division between larger artefacts and splinters or chips which is set at the 5 mm boundary for the flint artefacts and at 5 g for the other stone artefacts.

Table 6.6 Total number of flint and stone artefacts at De Bruin.

Flint	Amount		Weight (g)	
Phase 1	384	3.1%	3513	13.4%
Phase 2	10798	88.1%	19528	74.5%
Phase 3	1061	8.7%	3184	12.1%
Undertermined	20	0.2%	1	0.0%
Total	12263	100%	26226	100%

Stone *	Amount		Weight (g)	
Phase 1	22	1.3%	-	
Phase 2	1536	88.4%	-	
Phase 3	179	10.3%	-	
Total	1737	100%	23850	100%

* The large amounts of naturally occurring gravel are not included.

For phase 2, more than half of the analysed flint material could not be determined by raw material type (60%). The remaining artefacts are most often made from coastal flint or Meuse eggs[16] (23%) and northern flint (16%). Small amounts of 1% or less of terrace flint, Rijckholt flint, Light-grey Belgian flint, and Wommersom quartzite are found at the site. The flint could have come from areas both north and south of the locality. The Utrechtse Heuvelrug may be the most likely source of northern flint whereas the other types may be gathered at the coast, in the Meuse valley, or from the Meuse deposits in the middle of the Netherlands. Of the whole assemblage 36% was visibly exposed to heat. The flint debitage is mainly from the production of flakes, with blades made less often (table 6.7). The presence of cores and rejuvenation pieces, together with the many splinters, point towards production on the site. Yet, the general number of cores and rejuvenation pieces is somewhat low. Cortex is present on roughly 45% of the larger artefacts which is the result of the small dimensions of the nodules. Anterior patina is almost absent (2%). The tools form a different toolkit from that at Polderweg. Different types of microliths, along with trapezes and transverse arrowheads occur regularly. The percentage of scrapers is also higher and borers, burins and microburins occur. The remaining artefacts are all types of retouched flakes, blades and rejuvenation pieces. One splintered piece was found as well. Use-wear analysis revealed mainly traces of hide working while plant processing was encountered far less. Bone, antler and wood processing occurred occasionally. The evidence of hafting is limited as well (van Gijn et al. 2001b).

The flint material of phase 3 is less abundant. The raw material type could not be defined for a large part of the artefacts (60%). Two types are often seen, that is northern flint (19%) and coastal flint (18%). Terrace flint, Rijckholt flint, and Wommersom quartzite were used for a handful of artefacts (1% or less). Light-grey Belgian flint was not observed, whereas two large blades made of Rijckholt flint are seen as import products. However, the same provenance areas as in phase 2 can be expected. Of all the flint of phase 3 approximately 43% was exposed to heat. The production focussed on flakes although blades are rather frequent as well (table 6.7). Cores and rejuvenation pieces were equally present whereas chips form a smaller amount of the whole assemblage as in the previous phase. Cortex was visible on approximately 43% of the larger artefacts, which is much more than anterior patina (2%). The toolkit is very different from phase 2. There are no microliths; only trapezes and transverse arrowheads are recovered. Scrapers and borers, along with different types of retouched flakes, blades, and other pieces occur regularly. Again, one splintered piece was found as well.

16 Some of these Meuse eggs were 'opened' by using the bipolar technique.

Table 6.7 Total number of flint artefacts per typological category of the site De Bruin.

	phase 2	%	% >	phase 3	%	% >
Debitage material	**3196**	**30%**	**53%**	**370**	**35%**	**51%**
Flakes	1900	18%	32%	183	17%	25%
Blades	715	7%	12%	106	10%	14%
Rejuvenation pieces	350	3%	6%	45	4%	6%
Cores	231	2%	4%	36	3%	5%
Tools	**505**	**5%**	**8%**	**87**	**8%**	**12%**
Scrapers	55	0.5%	0.9%	12	1.1%	1.6%
Borers	21	0.2%	0.4%	2	0.2%	0.3%
Burins	2	0.0%	0.0%			
Microburin	1	0.0%	0.0%			
Combination tool	2	0.0%	0.0%			
Microliths	28	0.3%	0.5%			
Arrowhead	15	0.1%	0.3%	1	0.1%	0.1%
Trapezes	27	0.3%	0.5%	4	0.4%	0.5%
Transverse arrowheads	3	0.0%	0.1%	1	0.1%	0.1%
Tools on flake	204	1.9%	3.4%	34	3.2%	4.6%
Tools on blade	115	1.1%	1.9%	26	2.5%	3.6%
Tools on other blanks	24	0.2%	0.4%	5	0.5%	0.7%
Indet. tools				1	0.1%	0.1%
Indet. tool fragments	7	0.1%	0.1%			
Splintered pieces	1	0.0%	0.0%	1	0.1%	0.1%
Waste	**2284**	**21%**	**38%**	**275**	**26%**	**38%**
Subtotal ≥ 1 cm	***5985***	***55%***	***100%***	***732***	***69%***	***100%***
< 1 cm	**4813**	**45%**		**329**	**31%**	
Total	**10798**	**100%**		**1061**	**100%**	

Use-wear analysis revealed similar traces to phase 2 with the exception of wood working. Additional traces of contact with mineral substances were detected (van Gijn et al. 2001b).

The stone artefacts from phase 2, 1536 in total, were predominantly made from different types of quartzite (96%). The remaining types are sedimentary rocks (3%), mainly schist, and metamorphic rocks (1%). One fragment of radial pyrite was recovered as well. Most of the material can be found in the Meuse basin, or the ice-pushed ridges of the Utrechtse Heuvelrug and the Veluwe. One of the primary sources of pyrite is the Ardennes which does however not need to imply import from that area as the clay outcrops near Denekamp and Winterswijk are also a possibility (Van der Lijn 1973). The tools comprise 22 hammerstones, 3 grinding stones, 2 arrow shaft polishers, and 1 anvil. Additional information on heat exposure reveals that up to 64.3% of the assemblage showed traces of exposure while this was only 18.2% in the first phase.

The raw materials used for the artefacts of phase 3, only 179 pieces in total, are also mainly different types of quartzite (94%). Of the two remaining types, which are sedimentary rocks (4%) and metamorphic rocks (4%), schist is again the most numerous. Most of the material can be found in the Meuse basin, or the Meuse and Rhine deposits in the middle of the Netherlands. The limited number of tools is a combination of 3 hammerstones, 1 grinding stone, and 1 anvil. Here also traces of heat exposure reach as high as 71.5%.

The conclusions of the use-wear analysis are in the original publication presented as a whole and not separated by phase. One of the hammerstones was probably used as a pestle in combination with a mortar or anvil. Traces of red ochre give an indication of the possible contact material. The crushing of oil-yielding seeds or other plant material is also possible (van Gijn et al. 2001c). Another hammerstone may be a hammerstone / grinding stone combination whereas a third hammerstone is in fact a hammerstone / grinding stone / anvil combination.

In addition, it must be mentioned that the stone artefacts are much more fragmented than at Polderweg which is most likely the result of usage, and most weigh less than 20 g (86%). Stones heavier than 100 g are rare, while only one artefact over 2000 g was encountered. It is, however, not known how much the only stone artefact from phase 2 at Polderweg weighs.

Thus, the lithic industry of phase 2 consists of 1536 stone artefacts and 10.798 flint artefacts, which is 12% and 88% respectively. For phase 3 this division is very similar with 179 stone artefacts and 1061 flint artefacts, or 14% and 86%.

When all inorganic archaeological remains are taken into account, the flint artefacts (66%) outnumber the pottery (24%) and the stone artefacts (10%). When analysed per phase, flint artefacts (86%) and the stone artefacts (12%) both outnumber the amount of pottery (2%) for phase 2. A different composition is attested for phase 3 as the flint artefacts represent 53%, the pottery 38%, and the stone artefacts only 9%.[17]

Site function

De Bruin is very similar to the neighbouring site of Polderweg in terms of geological setting, faunal and floral remains, period of habitation, and accessibility to open water. Two almost identical sites located within a kilometre of each other are likely to be related in use and occupation.

The function of De Bruin as base camp is established by the activities represented by the different finds categories which are largely similar to Polderweg. For example, the local production of flint artefacts and tools is attested. Louwe Kooijmans (ibid: 513) mentions the high number of scrapers and points to small differences between the two sites. The shift in the toolkit composition is especially visible in the performed activities. Plant processing occurs far less at De Bruin, while wood working is represented more. Thus, the functions are largely similar, yet with different emphases and are complementary in other aspects. De Bruin shows that animals were hunted in a larger seasonal variation than Polderweg. Louwe Kooijmans sees De Bruin as a continuation of the function of Polderweg, as a base camp in the winter but with an extension as logistical base camp or extraction camp in summer. He relates this to the process of neolithisation and the increasing sedentism of the local hunter-gatherers with the introduction of agriculture. More technological innovation is confirmed in the wood, bone, and antler processing during the habitation of De Bruin.

Conclusion

De Bruin also shows certain similarities to the Swifterbant cluster and especially to site S3. The landscape of Pleistocene river dunes is very characteristic for both the twin site Polderweg – De Bruin as for Swifterbant. Similar game, prey and plants were hunted and gathered while activities performed on the sites are also very alike. However, bone chisels, combined with beaver and boar teeth chisels, were still used at De Bruin and Polderweg while the latter are missing at Swifterbant. By then, they may have been replaced by axes and stone flakes.

More surprising is the amount of stone artefacts, especially compared to Polderweg. The same tool types as seen at Swifterbant are already in use, with the exception of arrow shaft polishers. This specific type of tool was not recovered at the levee sites of Swifterbant. During phase 3 at De Bruin, they seem to be no longer in use either.

Similarities between the flint assemblages may also be observed. For example, trapezes and transverse arrowheads have been found in combination with scrapers and other types of retouched pieces. Nonetheless, the differences seem to prevail. First of all both northern and southern types of flint were gathered, from procurement sites located between 40 km and 150 km to the north and south from De Bruin. Besides trapezes and transverse arrowheads De Bruin yielded microliths, microburins, and Wommersom quartzite indicating the Mesolithic inheritance of the assemblage. During phase 3 the flint toolkit already shows more similarities with Swifterbant levee sites as only trapezes and transverse arrowheads were recovered; microburins also seem to have disappeared along with the microliths. Yet, at De Bruin some large Rijckholt blades have been imported suggesting lingering contacts with southern cultures, as does the presence of the Wommersom quartzite.

Comparison

Polderweg and De Bruin, which are located so close to each other, are occupied in roughly the same period of time. They provide a detailed insight into the economic, technological, and cultural evolution from the Late Mesolithic to the Early Neolithic. It may be questioned whether the two sites were used side by side as complementary settlements or activity areas, or successively or alternately. In this respect, Swifterbant sites S2, S3, S4 and S51 are very similar. For Hardinxveld-Giessendam it might be suggested that use of the sites varied, at times complementary, at other times used alternately. For example, in an earlier period, the Late Mesolithic occupation phase 1, it appears that De Bruin may have been used as a cemetery for the Polderweg site. During the occupation hiatus at Polderweg, between phase 1 and 1/2, the

17 The total number of retrieved potsherds is 4270 weighing c. 25,600 g. However, only fragments weighing 5 g or more, combined with fragments with stylistic characteristics, were studied in detail. Of these 266 belong to phase 2 and 767 belong to phase 3 (Raemaekers 2001b: 118).

possibility arises that the settlement was moved to De Bruin. When Polderweg was re-occupied De Bruin may possibly have been used as some sort of special activity site or annexe. Even more, habitation intensity, attested by the amount of artefacts and the character of the features, increases at De Bruin after the small dune top of Polderweg needed to be abandoned because of the rising water level (Louwe Kooijmans 2001a: 509-511, 2001b: 509-513). It is plausible that at that time, De Bruin permanently took over the function of settlement site as indications of huts are found.

Even though Polderweg phase 1 and De Bruin phase 1 are very much alike in stone and flint types, and thus in home range during the Late Mesolithic, this changes in later phases. De Bruin shows an extension of its territory or sphere of influence to the north starting from c. 5030 cal BC onwards whereas in earlier periods the focus was aimed at the south; this is attested by the near absence of and strong rise of northern flint. Still, in the later periods the connection with the southern hinterland is maintained, as illustrated by the large Rijckholt blades at De Bruin in phase 3 (Louwe Kooijmans 2001b). More differences may be observed between De Bruin phase 2 and Polderweg phase 2. For example, the (near) absence of Wommersom quartzite and stone artefacts sets Polderweg aside from De Bruin, just as the performed activities do. Hide processing is nearly absent at Polderweg, whereas it is the main activity at De Bruin. The same applies to plant processing, yet the other way around. Even large differences in the toolkit may be observed. One might wonder whether all these differences are the result of the small number of flint artefacts recovered from Polderweg. Even so, one of these aspects in itself may not seem that relevant, yet all aspects taken together clearly indicate many differences between the two sites.

The presence of typical Mesolithic tool types, such as microliths, may be the result of the admixture of older material. As this phenomenon is also present at Hoge Vaart and even Doel (see below), it is unclear how current microliths are in the earliest phase of the Swifterbant culture. The same might even apply to the use of Wommersom quartzite. Furthermore, the absence of *Breitkeile* at Polderweg and De Bruin is remarkable. During phase 2 of De Bruin this type of tool had already spread over the Dutch and North German plain (Raemaekers 1999, Verhart 2000a) and would therefore be expected at the site (Louwe Kooijmans 2001b).

6.2.4 Hoge Vaart

General aspects

The Hoge Vaart site is located near Almere, in the province of Flevoland. It was excavated between 1994 and 1997 as part of the A27 trajectory. The large coversand ridge, on which the site is located, has a north-south orientation with the former river bed of the Vecht in the east. The sand ridge was formed during the last ice age, occupied between 7800 and 5300 BP (c. 6650 – 4050 cal BC) and covered by peat from 5300-5200 BP onwards (c. 4000 cal BC). A large concentration of archaeological finds was attested on the middle of the sand ridge, the main occupation zone, while a small concentration to the north was investigated in detail as well. The full publication consists of 20 volumes, all focussing on different aspects of the research[18]. The last part by Peeters and Hogestijn (2001) is the summarizing volume; the details presented in the flint and stone artefact sections below derive from Peeters et al. (2001) and Peeters (2001) correspondingly.

The four chronological phases present on the site are based on radiocarbon dates, stratigraphical data, and archaeological characteristics (Peeters & Hogestijn 2001). The earliest occupation is established by a radiocarbon date from a hearth pit. This phase 1 is set in the Middle Mesolithic and is dated around 7800 BP (c. 6650 – 6600 cal BC). As this phase is dated by only one sample, it is unclear how it is related to the next phase. It may represent either the start of a continuous habitation or it may be the proof of an isolated occupation event. The second phase, which is Late Mesolithic, dates between 6400 and 6100 BP (c. 5400 – 5000 cal BC). For this phase, dates are also from charcoal samples from hearth pits, whereas stratigraphical data gives complementary evidence. The third phase is better delimited than the earlier phases. It starts after a period of erosion, which appears to have only affected the Mesolithic occupation surface, at c. 6000 BP and ends at 5650 BP (c. 4950 – 44750 cal BC). The last phase, phase 4, is even better defined. It is dated between 5400 and 5300 BP (c. 4300 – 4050 cal BC) and is set at the end of the Early Neolithic (Peeters 2009).

Phases 1 and 2 belong to the Mesolithic. The flint artefacts from these layers have a strong Mesolithic character with typical microliths such as triangles, B-points, C-points, and backed bladelets. And although Peeters (Peeters & Hogestijn 2001: 139) states that it is not absolutely certain these artefacts belong to the Mesolithic, their raw material type sets them aside from the Neolithic assemblage. Even more, they are clustered[19] in an area with hearth pits, quartzite and quartzitic sandstone artefacts, and a bladelet of Wommersom quartzite; a raw material often associated with the (late) Mesolithic in the (southern) Netherlands.

The two succeeding phases 3 and 4 belong to the Swifterbant culture. The pivot point seems to be 6050

18 Earlier publications are Hogestijn et al. 1995 and Hogestijn & Peeters 1996.

19 Although there might be a light increase of the microliths in the southernmost area of the main occupation zone, to me, based on the figure on page 98, the microliths are spread as a loosely knitted blanket over the whole coversand ridge. Therefore, in my opinion, the idea of a Mesolithic concentration or activity area in the southernmost part of the occupation zone needs further discussion.

– 6000 BP (c. 4950 – 4900 cal BC), when the use of hearth pits was replaced by that of surface hearths and pottery was introduced (Peeters & Hogestijn 2001: 141-143). The presence of this typical pottery and Swifterbant-like flint artefacts already gave some indication of the date during the extended coring campaign preceding the excavation (Peeters & Hogestijn 2001: 141). This cultural designation was confirmed during the excavations and following analyses. The division of the different Swifterbant phases used at the Hoge Vaart site is that of Hogestijn which is slightly different from that proposed by Raemaekers (see chapter 1). However, this has no influence on the material or the designation to the early or middle phase of the Swifterbant culture on this site.

The main categories of archaeological remains are flint and stone artefacts, pottery, bone, charcoal, wood, and charred vegetable food remains. The high fragmentation rate of most of these categories impedes a detailed definition; yet, an accurate picture could be formed. The pottery is of Swifterbant type with grit temper and some *randkerbung*. Evidence of on-the-spot production of pottery was found at the site, yet it appears it was made for direct use and a short life span, to be left behind as the group moved on (Peeters 2010: 158-159). The organic tools are defined as antler axes and bone awls, whereas three fish traps were recovered in the river bed, just as a wooden paddle. Furthermore, numerous bones of large and small mammals, fish, and birds were recovered. The bone fragments recovered from the top of the coversand ridge are too small to determine whether they come from wild or domesticated animals, while the fragments from the gully are less fragmented and represent wild species. The charred vegetable food remains are all from wild types. Loose human skeletal remains also occurred on the site.

The features on the site are numerous and diverse. Large and deep hearth pits with charcoal, deep pits without any significant archaeological remains, and surface hearths form one type, whereas stakes and poles form another. The hearth pits exclusively belong to the Mesolithic phases, while the surface hearths are Neolithic[20] and overlay the Mesolithic hearth pits. Two features are unique on the site; these are interpreted as a water pit and a clay processing pit. To the east of the site, in the river bed, three large clusters of poles are identified as fish weirs; remains of wattle were retrieved from one of them, whereas four tree-trunks are seen as some sort of platform. Finally, at different locations in the swamp at the outskirts of the site, three flint deposits have been found.

20 However, after calibration there seems to be an overlap between the latest hearth pits and the oldest surface hearths (Peeters & Hogestijn 2001: 131).

Lithic artefacts

The flint material is one of the most numerous finds categories at the site and consists of roughly 250,000 artefacts. As the material appeared to be a homogeneous assemblage, a sample of 25%[21] was believed to provide sufficient information on the typological, technological, and functional characteristics of this assemblage on the transition of the Late Mesolithic to the Early Neolithic (Peeters et al. 2001). As with De Bruin, the applied divisions needed to be recalculated for the categories and definitions used in this research. Therefore, the percentages in this publication differ from those in Peeters' publication. One of the major differences is the division between flakes and blades. Peeters' blades are characterised by a production in repetitive and parallel sequence and not so much by a 2:1 length-width ratio. Furthermore, all the material from the different phases was analysed in bulk, so no divisions or evolutionary tendencies can be seen. In the text, however, some elaborations are made by Peeters. Finally, the concentration of grey-green quartzite in the southernmost part of the trench, associated with the flint assemblage comprising microliths and the bladelet of Wommersom quartzite, belongs to the Middle Mesolithic phase, or even the Late Mesolithic phase, and will therefore not be discussed here. Nevertheless, Peeters (Peeters & Hogestijn 2001: 133) questions whether this material essentially deviates from the material of the Early Neolithic phase. As these artefacts are set aside from the Early Neolithic stone artefacts by their stratigraphical position and spatial association to the hearth pits, this reservation is correct as erosion was attested at the site.

Of the 25% sample a small set of 2174 artefacts were analysed thoroughly and individually, which is less than 1% of the total amount of flint artefacts recovered. The absence of postdepositional transformations suggests a good preservation of the assemblage. The material consists mostly of northern flint (84%), both with and without bryozoans. Southern flint types represent 3% whereas 13% could not be defined. One bladelet of Wommersom quartzite, believed to be of Mesolithic date, was recovered as well. Cortex and patina indicate that all the material originates from secondary contexts. For the northern flint these are presumably not the boulder clay deposits but more likely the periglacial sand deposits[22] in the Veluwe and at the beaches. The southern flint can be collected at outcrops of the Meuse deposits, for example the Utrechtse Heuvelrug; the Wommersom quartzite was imported from Belgium.

21 This still would be 62,500 artefacts. At least 30,661 or 30,677 artefacts have been studied in some detail (Peeters et al. 2001: 126, 132)

22 Peeters et al. (2001: 23) comes to this conclusion because of the homogeneous character of the material, its good quality and limited colour differences, in combination with the absence of pressure cones and frost fissures. Even more, the Utrechtse Heuvelrug and the Veluwe are located closer than the boulder clay outcrops at Urk and Schokland.

Heat exposure was only analysed for the sample of 2174 artefacts. Of these 18% showed visible traces of heat exposure. Although the division used by Peeters et al. (2001: 125, table 3) is different than the one used in this research, it could easily be recalculated. Light exposure occurs the least (2%), while medium (7%) and heavy exposure (9%) occur somewhat more.

Of the 2174 artefacts most are flakes and blades (48% and 39%), with a blade-flake ratio of 1:1.2 (table 6.8). Rejuvenation pieces and cores occur much less; the remaining pieces are waste and chips. It must be mentioned that an unknown number of these blanks are tools[23]. As these 2174 artefacts are a selective sample, it is unclear whether these percentages are representative for the whole assemblage or not[24]. The same accounts for the proportions of larger artefacts versus chips. In the sample this is 91% versus 9%, which seems rather elevated for a representative sample.

Table 6.8 Total number of flint artefacts per typological category of the site Hoge Vaart.

	Number	%	% >
Debitage material	**1956**	**99%**	**99%**
Flakes	1046	48%	53%
Blades	839	39%	43%
Rejuvenation pieces	40	2%	2%
Cores	31	1%	2%
Waste	**13**	**1%**	**1%**
Subtotal ≥ 1 cm	***1969***	***91%***	***100%***
< 1 cm	**205**	**9%**	
Total	**2174**	**100%**	

The tools are mainly a collection of trapezes, retouched blades and blades with visible use-wear traces, and scrapers (table 6.9). Retouched flakes occur less, whereas the other tool types are represented by only a few. The amount of tool fragments should not be neglected. This might be linked to the high fragmentation rate also observed for other artefact categories at the site.

Table 6.9 Total number of tools of the site Hoge Vaart.

	Number	%
Scrapers	54	11.9%
Borers	3	0.7%
Burins	1	0.2%
Microliths	6	1.3%
Arrowheads	1	0.2%
Trapezes	83	18.4%
Tools on flake	25	5.5%
Tools on blade	72	15.9%
Other tools	2	0.4%
Indet. tool fragments	78	17.3%
Strike-a-lights	4	0.9%
Visible use-wear	123	27.2%
Tools	**452**	**100%**

The raw material used for the tools is in similar proportions as the whole assemblage; only the projectile points show a different picture. For this specific type of tools mainly northern flint without bryozoans is selected; for the microliths this is 85%, for the trapezes 54%. For scraping and cutting tools this is mainly northern flint without bryozoans. According to Peeters this signifies a preference of good quality flint with as few impurities as possible for the production of projectile points; in other words blades of high quality flint were selected for the production of microliths.

In general, blades (65%) were more often used as blanks for tools than flakes (34%). Other types of blanks such as cores or rejuvenation pieces were exceptional (1%). Projectile points were almost exclusively produced from blades, scrapers mainly out of flakes.

The projectile points are mainly trapezes, especially symmetrical ones, and to a lesser extend triangles, B-points, C-points and backed bladelets. The latter are generally rather small, one even has surface retouch. The trapezes are not divided by length-width ratio. Therefore, relying on the drawings and information in the text, four might be transverse arrowheads. The trapezes gradually range from a length-width ratio of 3:1 to 1:1.5 or even less, thus from long and slender to short and wide. Their exact measurements vary from 4x4x1 mm for the minimum length, width, and thickness, and 27x17x4 mm for the maximum ones[25]. However, most cluster between 14x10x2 mm and 20x13x3 mm.

The scrapers are mainly single and double end scrapers. Based on the drawings, both scrapers with and

23 Even more, the numbers of tools used in the different tables do not totally correspond with each other. It is also not specified in the publication, i.e. Peeters et al. 2001, how many of these tools are incorporated in the set of 2174 artefacts.

24 Similar percentages of 45% and 40% for flakes and blades are given for the 30,661artefacts (Peeters et al. 2001: 132).

25 The dimensions of the tools in this paragraph are all approximate measurements as these are derived from the graphs in the publication (see Peeters et al. 2001: 91-98).

without retouched edges occur, just as rectilinear, curved, and round scraper fronts. A large variety of blanks is used, although flakes seemed to have the preference. Measurements range from 9x9x3 mm to 50x32x14 mm and cluster between 13x11x3 mm and 25x25x7 mm.

Retouched blades and flakes have mainly a retouched edge and are rarely truncated or notched. The blades form a cluster measuring between 19x7x2 mm and 68x23x9 mm; one blade is different measuring 56x9x11 mm. The flakes show a less dense cluster ranging from 8x3x2 mm to 43x49x14 mm. In this perspective the artefacts with visible use-wear traces should be mentioned as well. These are predominantly blades, and to a much lesser extent flakes, showing gloss on one or two edges. Peeters places all these tools under one heading, that of cutting tools. It must be mentioned that he observed that retouched blades and flakes are generally larger and somewhat thicker than their counterparts with use-wear traces (Peeters et al. 2001: 37).

Less common tools are burins, borers, and strike-a-lights. On the site some single finds were recovered as well; these comprise a flint hammerstone / *retouchoir*, a core axe, and a possible fragment of a flake axe.

Finally, the three flint deposits recovered at the edge of the peat should be mentioned. The first comprised 21 tested nodules and prepared cores, the second five exhausted blade cores and four large flakes, and the third roughly hundred flakes. Their isolated location and selective composition make Peeters interpret them as intentional, ritual deposits (Peeters et al. 2001: 59).

Additional information from use-wear analysis reveals the transverse hafting of the trapezes and their use as arrowheads. The scrapers and blades were mainly used for the primary stages of hide processing (fresh hides) and plant processing, and to a lesser extend for finer wood working activities like arrow shaft production. Traces of contact with bone or antlers are rare, just as the processing of dry hide. The latter was only performed with unretouched blades (Peeters et al. 2001: 39-45). Several artefacts show the rounding-off of a working edge or tip, related to the processing of a soft mineral substance. The question is whether this rounding-off is visible to the naked eye as with the artefacts at the Swifterbant sites.

Detailed attribute analysis (Peeters et al. 2001) revealed that the flint technology at the Hoge Vaart site was primarily aimed at the production of regular blades. Most of the flakes present at the site presumably originate from the early stages of blade production as there are no indications of systematic flake production. The blades were detached unipolarly, mainly have a triangular or trapezoid cross section and are lightly to moderately curved. Minimal length was approximately 30 to 40 mm, whereas width varied from 7 to 20 mm and thickness did not exceed 6 mm. They could be as long as 70 mm, and larger examples must have been present as well, proven by fragments of blades with a length up to 60 mm. If no suitable, natural striking platform was available one large flake was chipped off with direct, hard percussion. Primary testing, shaping of the nodule, and striking platform/edge renewal, often done at the procurement site, was also executed in the same manner. Blade production occurred along a guiding ridge in a unidirectional fashion (one platform) using indirect percussion or punch-technique. The angle to the production plane was controlled by removing flakes or a core tablet. Correction of production plain curvature or debitage errors were performed by removing flakes from the side or opposing platform, thus by reorientation of the core by a quarter turn or sometimes half a turn. Even when a second striking platform needed to be installed, maybe because the opposing one was depleted or just because the correction of the production plain curvature could occur, debitage would be performed from one platform only[26]. Blade production ceased, which most likely also meant the abandonment of the core, when correction was no longer possible as the core became too small or suitable blades could no longer be detached.

This production process resulted in regular blades, but also in less regular blades and all sorts of flakes. From this pool of blanks, specific types of blanks were chosen to be turned into specific tools; fine blades became trapezes, thicker blades became cutting tools, retouched or not. Peeters (Peeters et al. 2001: 60) states that these trapezes were produced using a microburin technique. Yet some may have been produced as on the Swifterbant levee sites by breaking blades. The cutting tools are mainly larger blades (40-60 mm) with limited curvature used for fresh hide and plant processing. Flakes were turned into scrapers, or just lightly retouched, and used for all sorts of tasks. Again, specimens with little or no longitudinal curvature were preferred. Although no other types of tools were produced on the site, maintenance of tool edges and re-use of artefacts has been established.

Peeters et al. (2001: 61) also mentions a handful of import products. Several large blade fragments and flakes were brought to the site ready-made as suggested by their exceptional raw material. Most likely some of the arrowheads might have been brought to the site as well, maybe even for retooling.

The number of stone artefacts is unknown, yet is presumably less abundantly present than the flint artefacts. In the main, the artefacts consist of crushed white quartz and red granite (95%), raw materials retrieved from the

26 Peeters refers to these cores with two opposing striking platforms as to "bipolar production" (Peeters et al. 2001). In my opinion "bidirectional" is more correct and it is this term that will be used. "Unidirectional from two opposing striking platforms" would also be correct, yet rather long as a term.

Utrechtse Heuvelrug and boulder clay deposits respectively. These two rock types were used as temper in the pottery found at the site. The material recovered from the occupation layer may therefore be interpreted as temper ready to be used. A function as cooking stone, especially for the larger quartz fragments, cannot be ruled out either (Peeters 2001b). The reasoning that the clusters of grit might be weathered or even disintegrated potsherds is in my opinion not likely because firstly 34 kg of potsherds are still present at the site and secondly large amounts of grit are widely spread over the southern half of the main occupation zone.

Another group of artefacts are clusters of quartzite, quartzitic sandstone, and sandstone. These comprise flakes, fragments, and tools. The latter are a sandstone arrow shaft polisher, a quartzite hammerstone, and a possible chopping tool produced out of quartzite. Another hammerstone, of quartz this time, was recovered as well. One of the main discussion points in this section, or for the whole site for that matter, is the Mesolithic designation of a cluster of quartzite flakes, chips, and fragments in the southernmost area of the main occupation zone. The artefacts from this cluster derive from the same grey-green quartzite cobble (Peeters 2001b). Although it is not explicitly mentioned in the text, the quartzite tools, and possibly other debitage material as well, are presumably from another type of quartzite, thus not from the same cobble. The question thus arises whether the grey-green quartzite cluster stands on its own or was accompanied by some of the other stone (quartzite) artefacts. In Peeters & Hogestijn (2001: 122, 130, 139) both quartzite and quartzitic sandstone artefacts are mentioned as part of this cluster. Furthermore, as the Mesolithic microliths were loosely spread over the whole coversand ridge, other stone material, of Mesolithic origin or not, may be as well. Peeters himself indicates that the arrow shaft polisher is a mainly Mesolithic tool (Peeters 2001b: 12). It is clear that the Mesolithic designation of some of the stone material is far from definite. On the other hand, it cannot be substantiated that all the stone material was of Neolithic origin either.

Thus, the lithic industry roughly consists of 250,000 flint artefacts, yet the amount of stone artefacts is unknown. As most of the stone material consists of grit, it is at least safe to say that the larger flint artefacts clearly outnumber the larger stone artefacts. For the pottery 2666 potsherds larger than 1 m^2 are counted, whereas the remaining part was defined as 'grit'.

Even a comparison by weight is hard to calculate. The stone material accounts for 18 kg of grit and 24 kg of larger artefacts, whereas the pottery is divided into 2.7 kg of 'grit' and 18.5 kg of potsherds. The flint material weighs 96 kg (Peeters et al. 2001: 7) or 78 kg (Peeters 2001b: 13) depending on the publication. Whether this division is also the weight difference between the total amount and the larger artefacts is unclear. Yet, the supremacy of flint, both in number and in weight, over the stone artefacts and the pottery is clearly established.

Site function

During the Middle and Late Mesolithic occupation phases, the presence of microliths may point to hunting activity. However, the presence of such tools do not exclude the possibly of other activities being performed. Even more, as it is uncertain whether some of the stone artefacts belong to this phase or not, and as the archaeological remains are according to Peeters (2009: 165) far too fragmentary, it is impossible to pronounce any further upon the character of the site during this period. Nevertheless, one of the most distinctive features, which sets these Mesolithic occupation phases aside from the Neolithic occupation phases, are the hearth pits.

Based on the little concentration in the northern area of the site, which showed distinct activity areas around a central hearth, it is argued that large parts of the Early Neolithic settlement area, dated to the early phase of the Swifterbant culture, were characterised by small hunting camps. These consist of a single hearth and a flint production oriented on archery and butchery. Associated with hunting, fishing, and fowling, and occurring with some regularity over a time span of several hundreds of years, they are thus not residential base camps or settlement sites. Because of the on-site pottery production, it was initially thought that the hunting camps may have occurred in association with or alternated with short term seasonal camps or occupation, in my opinion suggesting extended periods of stay[27] and habitation, at least to some extent. The nature of this occupation may also have been different in activities, group size and group composition (Peeters & Hogestijn 2001: 182-183). Yet, recent views suggest the pottery may have been part of the specialised hunting camps implying only short term occupation (Peeters 2010: 159).

Finally, the fish traps, fish weirs and paddle dated to the last phase, along with the absence of many other archaeological remains, indicates fishing, and possibly related activities, at the final occupation phase of the site. In other words, the Hoge Vaart site seems to be representative for only a few aspects of the Swifterbant habitation in the region (Peeters & Hogestijn 2001: 182-183).

Conclusion

The similarities between the Hoge Vaart site and the Swifterbant site are numerous. The absence of flint or stone material in the subsoil is observed at both sites, which forced the people from Hoge Vaart to obtain their flint from local and regional secondary contexts, possibly

27 With the term 'extended periods of stay' an occupation of roughly a week up to a few weeks is intended in this research, i.e. longer than 2-3 days.

located in the Veluwe and the Utrechtse Heuvelrug (8 – 20 km) but also at the beaches (c. 50 km), whereas the stone material could also be collected at the boulder clay outcrops of Urk and Schokland (40 – 50 km). Northern flint was predominantly selected for the whole assemblage, tools included, whereas southern flint was used very rarely. Even more, for projectile points mainly northern flint without bryozoans was selected, for scraping and cutting tools this was ignored. This indicates the selection of good quality flint with as few impurities as possible for the production of projectile points.

At Swifterbant, flint and stone was also collected from secondary procurement sites, presumably from the boulder clay outcrops at Urk and Schokland (10 – 14 km). No southern flint was observed at the site, possibly with the exception of polished flint axes. Wommersom quartzite was no longer observed either. The selection of good quality flint for certain tools is also attested, mainly for trapezes and blades with visible use-wear traces.

Only one system of debitage was used at the site of Hoge Vaart. Although the percentages of the analysed sample suggest a light dominance of flakes over blades, the operational chain was aimed at the production of regular blades with triangular or trapezoid cross sections. The production of flakes was not a goal on its own; flakes are considered to be a by-product from the early stages of blade production. In general, a rather low number of cores and rejuvenation pieces were recorded as some production stages were performed at the procurement sites. Core preparation was limited to the use of a natural striking platform or the detachment of one large flake with direct, hard percussion. Blade production occurred along a guiding ridge in a unidirectional fashion using the punch-technique. The production plane was controlled by removing flakes or a core tablet, or by reorientation of the core a quarter turn or half a turn. On top of that, Peeters suggested that some of the large blade fragments and flakes were brought to the site as finished products.

It may be clear that this operational chain formed the base of the flint production seen at Swifterbant. Low number of cores and rejuvenation pieces, the use of natural and simple striking platforms, and the dominance of flakes over blades are all observed at the Swifterbant site itself. More remarkable is the fact that the blade production technique at Swifterbant seems to be a further development of the technique already present at Hoge Vaart. They have used the technique and have 'taken it to the next level', to be performed by specialised or certain, skilled people, possibly at the procurement site of the nodules. For example, the same technique, i.e. controlling the production plane by reorientation the core a quarter turn or half a turn, was still used. The debitage technique used at the settlement site was more ad hoc and could presumably be performed by everyone at the site. People could produce functional, everyday tools for everyday tasks whereas the imported, regular blades were used for certain (other) tasks.

The flint tools from the Swifterbant phases at Hoge Vaart predominantly comprise arrowheads, scrapers and retouched blades. These are generally present in the large concentration or main occupation zone on the site. Based on the little concentration in the north, the larger concentration is presumed to be a collection of successive small hunting camps. It appears these are accumulated in an area of 10x50 m on the top of the sand ridge over an extended period of time. Within the small concentration clear activity areas could be distinguished and this may have been the case for all the little camps clustered in the main occupation zone. Both the trapezes and transverse arrowheads, together with the scrapers and retouched / used blades, dated to the Early Swifterbant phase, are very similar in typo-technology to the toolkit found on the Swifterbant levee sites.

The question remains as to whether typical microliths at Hoge Vaart belong to the Middle / Late Mesolithic phase or the Early Swifterbant phase. Peeters already expressed his concern on the subject based on raw material and location on the site. The raw material argument is reinforced when the microliths are compared. The use of northern flint without bryozoans is 85% for the microliths and 54% for the trapezes. The high standards for quality seem to be diminished. However, there are as many arguments that this discrepancy exists within a single culture or between two different cultures. Then again, the high percentage northern of flint without bryozoans is not reached at the levee sites at Swifterbant.

The typical hunting camp activities, such as the maintenance of arrows and the primary processing of game and hides, largely outnumber any other function the site might have had. The association with or alternation with other, short term seasonal camps or occupation is not at all proven as the local production of pottery may have been part of the specialised hunting camps. Even more, the presence of specific flint tools other than used for archery and butchery do not often occur. Burins or borers are rare, as are use-wear traces of bone and antler processing. Evidence of the production of baskets or mats may be associated with both occupation types. This also applies to the ritual flint deposits. Whether the absence of the bipolar technique and bipolar pieces[28] is the result of the differences in activities or solely a chronological feature was at the time of the Hoge Vaart publication unclear. This research reveals that the use of bipolar technique may not be the typical Neolithic characteristic that it was believed to be for so long. It may have become more popular and wide-spread or it just might have been related to

28 Peeters (Peeters et al. 2001: 63) uses the term *"pièces esquillées"*.

the presence and use of very small nodules (see sections 5.5.5 and 5.7.4 and van Gijn & Niekus 2001).

Some comparisons with the Swifterbant levee sites S2 and S51 may be seen, yet none of them has such a pronounced hunting camp function. The use of blades and scrapers as the main tool type is one of the similarities with Hoge Vaart, just as is their use for hide processing. The frequent traces of plant processing at S2 and S51, combined with the lesser amount of trapezes, is a difference suggesting a wider variety of activities at Swifterbant. This might possibly be linked to longer occupation phases. In this respect, the presence, or absence, of a cemetery, stands out.

The activities performed with stone artefacts are much more diverse at Swifterbant than they are at Hoge Vaart. The amount of stone tools at the latter is very small and it was already suggested by Peeters that the transport of stone material to the Hoge Vaart site had one main goal, i.e. the use as pottery temper. Therefore, the specific selection of certain cobbles, possibly with a specific function already in mind, is attested at both Hoge Vaart and Swifterbant, yet is of a totally different nature.

6.2.5 Doel

General aspects

During the construction of the Deurganck dock in the Antwerp harbour a coversand landscape was revealed in the former floodplain of the river Scheldt. Between 2000 and 2005, three sites were uncovered in the area, all located on late glacial coversand ridges. Both the find circumstances and the working conditions of the salvage excavations were far from ideal, as for example some of the sites were already partially destroyed before research could begin. Still, the importance of these finds for the understanding of the neolithisation process of the sandy lowlands of northern Belgium was obvious from the start (Crombé et al. 2009). The information presented in this section derives from Bats et al. 2003, Crombé et al. 2000, 2002, 2004, 2009, Crombé 2005, and Sergant et al. 2006. These are mainly preliminary research articles as the archaeological material has not yet been studied in full detail. The exact number of most artefact types is therefore unknown. Still, two small samples of the different flint concentrations were analysed by Frederik Wuyts (2006) (Final Mesolithic) and Gunther Noens (2003) (Federmesser) as part of their master theses at the Ghent University, as was the pottery by Johanna De Saeger (2002-2003). Analyses on the palaeo-environment, chronology, and features at the site have thoroughly been conducted and published by Crombé (2005).

Site 1, located on a narrow coversand ridge, consists of two separate sectors approximately 100 m apart (zone B and C). Site 2, roughly 1200 m southwest of site 1, is positioned on a coversand ridge as well. This site was excavated in two seasons (zone J and L) and revealed three separate concentrations (C1, C2, and C3), located roughly 50 to 60 m apart from one another (Bats et al. 2003). On site 3, another narrow ridge located approximately 500 m southwest of site 2, only one excavation (zone M) was conducted.

All three sites at Doel were occupied in both the Early Mesolithic (c. 8000-7500 cal BC) and the Final Mesolithic[29] (c. 6000-5800 BP or 4550/4500-4000 cal BC)[30] (Sergant et al. 2006: 53, Crombé et al. 2009). This was established by radiocarbon dates and the techno-typology of the archaeological remains. The pottery pinpoints the occupation in the Early Swifterbant phase. The presence of a few potsherds showing affinities to the material of the Middle Swifterbant phase may also be attested although in very low amounts. Whether this indicates a second, somewhat later occupation phase, or whether this places the whole assemblage in a later phase is still unclear. Site 1 has two additional occupation phases. The typo-technological characteristics of the flint artefacts revealed the Final Palaeolithic material from site 1 zone B to be a Federmesser assemblage, whereas the flint and the pottery from the Middle Neolithic occupation phase recovered at site 1 zone C proved to be a Michelsberg assemblage.

At the time of the Final Mesolithic occupation the wet living conditions in the region had already restricted the available occupation areas to the top of the sand ridges. Therefore, the material discussed here was exclusively retrieved from the top zone of the ridges (Crombé et al. 2009).

The Swifterbant occupation area at site 1 consisted of two zones with lithic artefacts, pottery, and burnt organic material, such as bone fragments, hazelnut shells and seeds, pointing towards small spectrum subsistence. The bone fragments, often occurring in small concentrations, are generally highly fragmented impeding a good determination. Yet, the bones presumably all originate from wild mammals, such as red deer and boar, combined with fish, mainly cypriniformes and pike (Van Neer et al. 2001). The find of a single cereal grain (naked wheat: *Triticum aestivum*) is the only evidence of domestication at the site (Sergant et al. 2006: 56). Besides this settlement waste, about a hundred hearth pits were recovered in zone B, and a dozen in zone C. However, the disturbance at the site may have destroyed an unknown number of them. Although these hearth pits occur at different stratigraphical levels, the absence of pottery in their filling

29 This occupation phase is in some of the above mentioned articles referred to as the Late Mesolithic / Early Neolithic (i.e. Crombé et al. 2000).

30 Some dating discrepancies between food crust samples and carbonised plant and faunal remains were discovered during the course of the research. For more details see Crombé et al. 2009: 567.

may suggest a Final Palaeolithic or Late Mesolithic date (Crombé 2005, Crombé et al. 2009). Whether this also accounts for the dozen hearth pits in zone C is unknown (Sergant et al. 2006).

The pottery of site 1 zone B[31] shows a strong morphological resemblance to the Early Swifterbant material of the Netherlands. Noteworthy is the tempering with mainly grog (also known as *chamotte*) and organic material. On all other Early Swifterbant sites this is grit. Other characteristics are, however, very similar. A few potsherds are, based on the different morphology and decoration style, possibly related to a later habitation event at the site dated to the Middle Swifterbant (Crombé et al. 2000: 116). The potsherds resemble those from Hazendonk 2 and Bergschenhoek (see Louwe Kooijmans 1976: 258, 264).

At site 2, pottery was retrieved from C1 only, the Swifterbant concentration. The material is similar to that of site 1 zone B with grog and organic material temper, small knobs, and *Randkerbung*. One potsherd shows perforations just below the rim.

The Swifterbant occupation area of site 3 is also characterised by flint, pottery, and burnt bone fragments of mammals and fish. The latter are sometimes found in small concentrations, often in thin clay lenses, and may therefore possibly be interpreted as hearths. The substantial number of potsherds, spread over the site, clearly shows the same techno-typological characteristics as the Swifterbant pottery on site 1 and site 2.

Lithic artefacts

In contrast to the pottery, the lithic artefacts have not yet been studied in full which prevents the presentation of exact numbers. However, some observations on the flint material were made, in the field or otherwise, which leads to the following general descriptions for the three sites. None of the stone artefacts are mentioned in any of the published articles. Crombé and Sergant (pers. comm. 2009) informed me that their number is limited from a handful up to a few dozen per Swifterbant site. Below the research by Wuyts (2006) is addressed, providing some exact numbers of the different flint artefact types at site 1 zone B. It must be mentioned that the analysis by Wuyts is limited to a small area within the site.

As the flint material of the Swifterbant assemblage from site 1 zone B was concentrated in the upper 10 cm of the coversand deposits, and the Federmesser assemblage was dispersed over 30 to 40 cm, the material was slightly mixed. This leads to no difficulties as to what type of artefacts are concerned, but is more problematic for less diagnostic material. Still, a number of artefacts are clearly related to the Final Mesolithic Swifterbant occupation phase. These consist of regular (Montbani) blades[32], microliths, and artefacts made out of Wommersom quartzite such as small scrapers. The microliths mainly are small symmetric or weakly asymmetric and rectangular trapezes. Three other microliths occur, a B-point, a C-point, and a triangle. The trapezes are smaller than their Late Mesolithic counterparts and also of a different morphology, which predominantly is rectangular and rhombic in the sandy lowlands of Belgium (Crombé et al. 2002: 700). The absence of indirect, basal retouches and of microburins at the Doel site is also significant.

Worth mentioning is the presence of a possible flint cache containing one prepared core and nine large and complete blades. Based on technological criteria, Crombé et al. (2000: 118) cautiously designates this assemblage as belonging to the Federmesser-complex.

In order to facilitate the conclusion in sections 6.3 and 6.3.9, the Middle Neolithic flint material is presented as well. It consists of leaf-shaped points, transverse arrowheads, a robust retouched blade fragment, and a fragment of a polished axe made out of mined flint. Part of this Michelsberg assemblage is made of a black coarse-grained flint type of high quality, which is not attested in zone B, and was probably imported from one of the flint mines in southern Belgium (Hubert 1980).

The unfavourable research conditions and the distortion of the finds distribution largely limit the amount of spatial information that could be gathered. A small sector in the southeastern area forms the exception. The spread of the material restricted to the top of the ridge was confirmed and it also appears that the pottery clustered in areas of 5 to 10 m^2. The potsherds in some of these areas clearly belonged to one or a limited number of pots. The presence of the Federmesser-assemblage clouded the possible spatial relation between the Swifterbant flint artefacts and the pottery. Yet, in the southernmost unit the distribution of a cluster of artefacts made out of Wommersom quartzite demonstrated great similarities with the distribution of the pottery (Crombé et al. 2000).

The flint material from site 2 C1 and site 3 has only received preliminary study, resulting in little published information. The assemblage from site 2 C1 is rather limited and does not contain any apparent tools. Nevertheless, research at the site revealed that the excavated area must have been the periphery of a much larger site (Bats et al. 2003: 57). The material from site 3, both flint and stone artefacts, is the same as the Swifterbant material from the other sites, just as site 2 (pers. comm. Ph. Crombé 2009).

A pilot study in use-wear analysis on 26 scrapers and 25 retouched and blank flakes and blades suggests the

31 The pottery from zone C is defined as Michelsberg pottery (Crombé et al. 2002: 704).

32 Crombé et al. (2009) refers to these "long parallel and regular blades" (thus with straight edges and two parallel ridges, and often with small retouches) as Montbani-blades in the definition as Rozoy intended (Rozoy 1967).

Table 6.10 Total number of artefacts per typological category and number of burnt and unburnt artefacts of site Doel.

	Number	%		Burnt	%	LB	MB	HB
Debitage material	**741**	**9%**		**213**	**29%**			
Flakes	197	2.5%	*35%*	54		25	5	24
Flake fragments	371	4.6%	*65%*	126		27	17	82
Total flakes	***568***							
Blades	77	1.0%	*51%*	17		7	1	9
Blade fragments	74	0.9%	*49%*	14		6		8
Total blades	***151***							
Rejuvenation pieces	8	0.1%						
Cores	6	0.1%		1		1		
Burin spalls	5	0.1%		1				1
Micro-burins	3	0.0%						
Tools	**103**	**1%**		**12**	**12%**			
Scrapers	28	0.3%		5		4		1
Borers	1	0.0%						
Burins	1	0.0%						
Rounded pieces	2	0.0%						
Trapezes	3	0.0%						
Microliths	2	0.0%		1			1	
Tools on flake	16	0.2%		1		1		
Tools on blade	12	0.1%		3				3
Montbani-blades	9	0.1%		1				1
Retouched chips	9	0.1%						
Indet. tools	2	0.0%						
Indet. tool fragments	18	0.2%		1				1
Bipolar pieces	**2**	**0.0%**						
Visible use-wear	**4**	**0%**		**0**				
Other	**1**	**0%**		**0**				
Waste	**132**	**2%**		**115**	**87%**			
Indet. fragments	132	1.6%		115		16	17	82
Subtotal ≥ 1 cm	***983***	***12%***		***340***	***35%***	***87***	***41***	***212***
						26%	12%	62%
< 1 cm	**7047**	**88%**		**2322**	**33%**	**233**	**192**	**1897**
						10%	8%	82%
Total	**8030**	**100%**		**2662**	**33%**	**320**	**233**	**2109**

LB: lightly burnt flint, MB: medium burnt flint, HB: heavily burnt flint.

processing of dry hides, wood working, and plant processing. One blade shows great similarities with the sickle blades of the Linearbandkeramik. As agriculture is presumed to be absent at the site, this artefact, which had been re-worked into a scraper, may very well have been imported from a LBK, Rössen or Michelsberg site. Two double strike-a-lights have also been identified (Beugnier 2007).

The research conducted by Wuyts (2006) gives more detail on a sample of the lithic material. In total 8030 lithic artefacts, collected from an area of 6x9 m in zone B of site 1, were analysed. As the material appears to be divided into two groups based on largest dimension, that is length or width, the data cannot be compared to the analysis conducted in this thesis which is divided into two groups based on the length according the debitage axis (see section 3.1.2). Therefore, the data of the Doel site is taken from its original database provided by Wuyts and redefined using the methodology applied in this study. The numbers and percentage published here will consequently differ from those published by Wuyts. The

Table 6.11 Division of raw material of site Doel.

	Number	Flint	Tienen	Wommersom	Sandstone	Indet.
Debitage material	**741**					
Flakes	197	196		1		
Flake fragments	371	369	1	1		
Blades	77	75		2		
Blade fragments	74	57		17		
Rejuvenation pieces	8	8				
Cores	6	6				
Burin spalls	5	4		1		
Micro-burins	3	3				
Tools	**103**					
Scrapers	28	28				
Borers	1	1				
Burins	1	1				
Rounded pieces	2	2				
Trapezes	3	3				
Microliths	2	2				
Tools on flake	16	16				
Tools on blade	12	10		2		
Montbani-blades	9	7		2		
Retouched chips	9	9				
Indet. tools	2	2				
Indet. tool fragments	18	18				
Bipolar pieces	**2**	2				
Visible use-wear	**4**	4				
Other	**1**					1
Waste	**132**					
Indet. fragments	132	129			1	2
Subtotal ≥ 1 cm	***983***	***952***	***1***	***26***	***1***	***3***
		96.8%	0.1%	2.6%	0.1%	0.3%
< 1 cm	**7047**	**6998**	**1**	**41**		**7**
		99.3%	0.0%	0.6%		0.1%
Total	**8030**	**7950**	**2**	**67**	**1**	**10**

analysis reveals that the larger part of the material (88%) consists of artefacts < 1 cm (table 6.10). The remaining 983 artefacts are defined as 741 pieces of debitage material, 103 tools, 2 bipolar pieces, 4 artefacts with visible use-wear traces, 1 hammerstone, and 132 pieces of waste. The raw material is mainly flint, whereas 2 artefacts were made out of Tienen quartzite and 67 out of Wommersom quartzite (table 6.11). Furthermore, 1 sandstone fragment and 10 artefacts or fragments of an unspecified rock type are attested as well. The fine-grained flint is of fairly good quality and of secondary origin as indicated by the weathered cortex. Remnants of this type of natural surface are present on 34% of the artefacts larger than 1 cm[33]. The preference for flint is noticeable, particularly for the tools where the only exceptions are four blades produced out of Wommersom quartzite. It is this type of quartzite that occurs most often and especially in the form of blades. Heat exposure occurs equally often with the artefacts < 1 cm (33%) as with the artefacts ≥ 1 cm (35%). In both cases the heavily exposed artefacts largely outnumber the lightly

33 The number of artefacts with cortex in the text by Wuyts (2006: 68), and consequently their percentages, does not correspond to the total number of artefacts larger than 1 cm. However, the database provided by Wuyts revealed the adequate information. This also applies to other information in the text above.

Table 6.12 Percentage of natural surface on artefacts ≥ 1 cm of site Doel.

	Number	0%	%	1-25%	25-50%	50-75%	75-100%	fragm.	%
Debitage material	**741**								
Flakes	197	96	49%	57	7	20	17		51%
Flake fragments	371	260	70%					111	30%
Blades	77	47	61%	19	6	1	4		39%
Blade fragments	74	58	78%					16	22%
Rejuvenation pieces	8	6	75%	2					
Cores	6	3	50%	1	1			1	
Burin spalls	5	5	100%						
Micro-burins	3	3	100%						
Tools	**103**								
Scrapers	28	14		7		2	1	4	
Borers	1	1							
Burins	1	1							
Rounded pieces	2	1				1			
Trapezes	3	3							
Microliths	2	2							
Tools on flake	16	12		4					
Tools on blade	12	10						2	
Montbani-blades	9	8		1					
Retouched chips	9	9							
Indet. tools	2	1		1					
Indet. tool fragments	18	14						4	
Bipolar pieces	**2**	**2**							
Visible use-wear	**4**	**4**							
Other	**1**	**1**							
Waste	**132**								
Indet. fragments	132	86						46	
Total	**983**	**647**		**92**	**14**	**24**	**22**	**184**	
		66%		**9%**	**1%**	**2%**	**2%**	**19%**	

or moderately burnt artefacts (table 6.10). For the chips this number is as high as 82% of the burnt specimens. It appears that debitage material (29%) is burnt more often than tools (11%). The predominance of waste material being exposed to heat (87%) might be the result of the typological classification of the artefacts (see below).

The flakes are divided into a group of intact pieces (35%) and a group of fragmented pieces (65%). Of the intact specimens approximately half of them are covered with natural surface, such as weathered cortex, for the fragments this is only 30% of them (table 6.12). A total of 17 intact flakes (9%) can be considered decortication flakes as they are covered for up to 100% with cortex. The dimensions of the flakes are analysed for the intact specimens only. The minimum length, width, and thickness are 10x6x1 mm while the maximums are 51x46x15 mm. This results in average measurements of 18x15x4 mm. The length-width ratio shows an average of 1.3 with a minimum and a maximum of 0.5 and 1.9 respectively. The averages of the length-thickness ratio and width-thickness ratio are 5.1 and 4.1 respectively. Wuyts observed that one flake has a double bulb while another flake fragment, which is covered with a bluish patina, presumably belongs to the Federmesser assemblage.

For the blades the group of fragmented specimens (49%) is almost as large as the group of intact blades (51%). Up to 39% of the intact blades are covered with weathered cortex; four specimens can be defined as a decortication blade (5%). Of the fragmented blades, only 22% is covered with cortex (table 6.12). The measurements of the intact blades are 11x3x1 mm for the minimum dimensions and 62x31x14 mm for the maximum dimensions resulting in averages of 22x9x4 mm. The average of the

2.6 length-width ratio is the outcome of a minimum of 2.0 and a maximum of 6.0. The averages of the length-thickness ratio and width-thickness ratio are 7.7 and 3.0 correspondingly. As a note, Wuyts wrote that nine blade fragments have a regular appearance; seven of these were made out of Wommersom quartzite.

The remaining debitage material is rather limited in number. Of the eight striking edge rejuvenation pieces six are intact. They have minimum measurements of 10x3x3 mm and maximum measurements of 20x31x11 mm. All but one have the dimensions of blades. The six cores consist mostly of fragments. The two intact specimens both have one striking platform and measure 28x35x26 mm and 31x37x29 mm. Other artefacts are five burin spalls and three microburins. It should be mentioned that all three microburins are of the Krukowski-type, thus chipped off accidentally. The toolkit is dominated by scrapers and to a lesser extent by retouched flakes and blades. The scrapers are mainly produced on flakes, fewer on blades and one on a core. Most of them are single end scrapers, with or without retouched edges, two double end scrapers occur, and at least two round or oval scrapers were defined as well. Based on the drawings by Wuyts (2006: 164) the scraper fronts are often curved and rounded for the ones produced on flakes and straight or curved for the ones on blades. One scraper with a denticulated edge appears to be the only one that deviates from this pattern. The undamaged specimens measure between 13x17x3 mm and 39x27x11 mm. Based on the presence of a white patina, one scraper is defined as belonging to the Federmesser assemblage (ibid: 74). The retouched flakes mainly have retouches that follow the edge, only one is denticulated and two are truncated. The intact specimens measure between 10x12x2 mm and 31x25x10 mm. The retouched blades have similar retouching patterns as the retouched flakes since only one is truncated. Here measurements vary from 31x14x6 mm to 45x11x6 mm. As some of the fragmented retouched blades are as large as 52x21x9 mm the intact specimens were originally not the largest. Wuyts observed a gloss on the edge of one of the blades. Moreover, this is one of the most regular retouched blade fragments. The Montbani-blades roughly fall within the same dimensional range as the retouched blades, even though four are longer than 55 mm in length. Other tools are: 1 borer, 1 burin, 2 rounded pieces (possibly strike-a-lights), 3 trapezes, 2 other microliths, 2 indeterminate tools, 18 indeterminate tool fragments, and 9 chips with retouch occur. Of the three trapezes only one is complete (15x14x3 mm); of the other microliths one is a crescent and the other a fragment (possibly from a trapeze). The two bipolar pieces are rather small, 13x14x3mm and 13x19x5 mm, and are presumably of the irregular type. The 4 artefacts with visible use-wear traces are all blades with small use-retouches but no visible gloss. The hammerstone was made from a pebble of an unspecified rock type. It is unknown where the impact traces are located or how much it weighs but as the artefact only measures 36x23x15 mm it possibly may be a *retouchoir*. Finally, the definition of the waste material is limited to the use of the type “indeterminate fragments”. One might wonder to which extend these include potlids, frost flakes, and nodules. Considering the high number of burnt artefacts (87%) it is likely that potlids might form a large part of them.

To conclude the lithic section, it must first be stated that the sample of Doel is limited and therefore all interpretations are under some reservation. It is noticeable that, besides flakes and blades, the debitage material like cores and rejuvenation pieces is limited. However, large amounts of chips have been recovered from the small study area. The preference for flint is obvious, that is gathered locally from a secondary procurement site. The presence of low numbers of exotic material, often finished products or usable blanks, is also observed. The debitage is aimed at the production of flakes of which the largest were selected as blanks for the tools. The same selection technique is observed for the blades. The large blades, especially those made out of Wommersom quartzite, were not produced within the study area and may very well have been imported. The wide typological variety of debitage material and tools suggests a rather broad-spectrum site.

The presence of the crescent and absence of true microburins must be addressed. As many Final Mesolithic Swifterbant sites, the site of Doel was also inhabited during the Late Mesolithic. Therefore, this microlith may, along with the B-point, C-point, and triangle found at the site, be intrusive. Still, it cannot be entirely ruled out that these types of arrowheads were not still made during the early Swifterbant. The same applies to the limited number of “other microliths” at Hoge Vaart.

The spatial information reveals some clustering of the material, especially in the southeast corner of the study area, an area characterised by one or more surface hearths[34]. Most of the tools are randomly spread over the whole study area, not showing any special activity areas; only the scrapers seem to have a southern clustering. On top of that, the artefacts made out of Wommersom quartzite clearly cluster in the southeast corner.

Thus, the lithic industry consists of at least 8030 flint artefacts and an unknown number of stone artefacts. Nonetheless, the stone artefacts are very few, indicating the dominance of the first over the latter.

The pottery of site 1 zone B consists of 637 potsherds[35] (De Saeger 2002-2003). When all inorganic material is

34 Radiocarbon dates from charcoal taken from the hearth(s) range between 4540 and 4330 cal BC (Van Strydonck & Crombé 2005: 203).

35 Approximately 150 pieces of pottery are smaller than 1 cm^2 and are therefore defined as grit (De Saeger 2002-2003: 37).

taken into account, the flint material (c. 92.2%) is still predominant, outnumbering both the pottery (c. 7.3%) and the stone artefacts (c. 0.5%).

Site function
The evidence of wild mammal and fish bones, combined with the presence of wild food plants, points towards a preference of hunting, fishing, and gathering. The lack of bird remains does not need to imply the absence of fowling. The poor excavation conditions and taphonomic phenomena may be of influence as well. This may also apply to the deficiency of otter and beaver remains, so often present at other Swifterbant sites. Another significant absence is that of fish traps and fish weirs. The occurrence of flint artefacts such as trapezes and retouched blades support the existence of hunting and food processing activities. However, several flint tools signify a wider range of activities, such as the processing of dry hides and plant material, indicating habitation of a somewhat extended duration.

The absence of domesticated animals and grain gives no evidence of any form of domestication at the sites. The single grain of naked wheat (*Triticum aestivum)* may point towards agriculture by the Swifterbant people or by other communities. It has been assumed that the coversand ridges of Doel are too small and wet to produce grain at the sites itself, yet, this was assumed for the Swifterbant sites as well, and this for more than 30 years, before the hoe-field was discovered. Even so, the cereal grain more likely suggests contacts with cereal producing communities as naked wheat is generally present at sites from the Blicquy group, Rössen culture, Bischeim group and Michelsberg culture and not at Swifterbant or Hazendonk sites (Out 2009: 429). The single sickle blade (Beugnier 2007) found on site 1 may also have been obtained by exchange, some other form of contact, or may just be interpreted as being picked up from as site somewhere.

Conclusions
The presence of Final Palaeolithic, Late Mesolithic, and Middle Neolithic assemblages indicate the favourable living conditions at the site. Therefore, it is no surprise that the coversand ridge was repeatedly inhabited during the Early Swifterbant phase. Just as for Swifterbant, a wetland environment is a preferred location. Floral and faunal resources are very similar to those from Swifterbant with the exception of domesticated food resources, a characteristic Doel shares with all other Early Swifterbant sites.

Even if the conclusions of the flint material for the different Swifterbant sites at Doel are largely based on a sample of the material, the interpretation is still usable in general. The flint is of local origin and collected from a secondary source which might be the reason for the rather limited size of the cores and flakes. Yet, as the procurement sites are unknown, the travelled distances to acquire the raw material cannot be calculated. Just as at Swifterbant, the dominance of flake debitage is attested at the site whereas blades occur far less. This is also reflected in the cores that mainly have flake negatives. The few larger and regular blades, just as the Wommersom blades, were most likely not produced at the site. At Doel, the tools were most often made from flakes and are defined as scrapers (27%), retouched flakes (16%) and retouched blades (20%). Other tools such as borers, burins, rounded pieces, and bipolar pieces occur rarely. The arrowheads are presumably limited to trapezes (3%), as it was argued that the "other microliths" belong to an earlier Late Mesolithic inhabitation phase. This is most likely also the case for the microburins. The production of trapezes during the Swifterbant phase was most likely accomplished by truncation and fracturing, a characteristic observed at the Swifterbant type site as well.

The use-wear analysis on scrapers and (retouched) flakes and blades suggests the processing of dry hides, wood working, and plant processing, whereas strike-a-lights have also been identified. Along with the typological composition of the tools, this evidence points to various activities performed at the site. Even though the archaeological evidence only suggests habitation of a somewhat extended duration, the sites at Doel shows clear similarities with Swifterbant sites S3 and S4, and by extension even to site S51.

6.2.6 Brandwijk

General aspects
The excavations at Brandwijk were part of the *Donkenproject* of the Institute of Prehistory of the Leiden University (see van Gijn & Verbruggen 1992, Verbruggen in prep., Raemaekers 1999). The goal was to investigate whether the occupation of the Hazendonk site, 4.5 km to the southeast of Brandwijk, is representative of some hundred river dunes in the Alblasserwaard region. It turned out that most, if not all, river dunes under investigation were inhabited or used in some form or another during the Neolithic (van Gijn & Verbruggen 1992). Brandwijk - Het Kerkhof appeared to be one of the top locations. The site is located at the edge of a small river dune in the Lower Rhine and Meuse area, some 250 m southeast of the better known and larger River Dune of Brandwijk. Typical of these river dune sites are the waste layers surrounding the dune body. The extensive coring campaign revealed this promising site and a small area was subsequently excavated focussing on these waste layers. At approximately 4000 cal BC the dune must have been 1 hectare large and was clearly protruding out of the surrounding alder carr by roughly 4 m. Open water, and easy access, was present less than 15 m south of the dune. The waste layers were located on the south side of the dune, between the dune body and the open water (van Gijn & Verbruggen 1992: 351).

Of the four waste layers, three were exposed during the excavation. The layers, numbered L30, L50, and L60, were separated by peat and filled with charcoal, burnt bone, pottery, and flint artefacts. The oldest finds layer, L30, dates to 4610-4550 cal BC. The middle layer, L50, dated by several charcoal samples, may be divided into three sublayers (Van Hoof 1994, Raemaekers 1999, 2001b). The base and the top layer were filled with finds while the intermediate layer was poorer. The range for the base layer is 4220 – 4100 cal BC, while the top layer probably dates between 4030 and 3940 cal BC. The final layer, L60, is dated between 3940 and 3820 cal BC. At their greatest extent, the layers covered an area of approximately 1600 m² (Verbruggen in prep., Raemaekers 1999: 43-44, 201-202).

The cultural designation of the Brandwijk site to the Swifterbant culture is based on the presence of the typical Swifterbant pottery (Raemaekers 1999, 2001b). Initially, the few potsherds from L30 could not convincingly be related to the Swifterbant culture (Raemaekers 1999: 54) as they showed both differences and similarities to the material from layers L50 and L60. However, after the analysis of the pottery of Polderweg and De Bruin the similarities to the material from Brandwijk layer L30 became apparent which resulted in the allocation of layer L30 to the Swifterbant culture (Raemaekers 2001b: 144-145). This dichotomy between layer L30 on the one hand, and that of layers L50 and L60 on the other, also applies to the flint tool spectrum (see below). As the flint material from L30 is hardly diagnostic, the cultural designation of this layer is largely based on the characteristics of the pottery. Yet, based on the radiocarbon dates, Lanting & Van der Plicht (1999/2000) also assume a position at the transition from the early to the middle Swifterbant phase while layers L50 and L60 are clearly designated to the Middle Swifterbant phase.

Within the waste layers, no camp or hut structures have been found, only a row of pointed poles on the edge of the dune at the waterside. The finds consist of more than 4000 items, including artefacts of bone, antler, flint, and also pottery. The latter is discussed by van Gijn and Verbruggen (1992: 352) who see a large resemblance between the Brandwijk pottery and the Hazendonk 1 pottery, and is discussed in detail by Raemaekers (1999: 44-55). Raemaekers (2001b: 144-145) concludes that the potsherds from layer L30 show similarities to the material from De Bruin while the potsherds from layers L50 and L60 are defined as Swifterbant pottery which show resemblance to the material from the contemporaneous Swifterbant levee sites.

The artefacts of bone and antler are awls and chisels. Besides these, numerous bones of local wetland fauna are encountered such as otter, beaver[36] and red deer along with bones of pig/wild boar and sheep/goat (Raemaekers 1999: 59-61, van Gijn & Verbruggen 1992: 352).

Lithic artefacts

For the flint artefacts, the same two references are consulted. The preliminary research (e.g. van Gijn & Verbruggen 1992) based on approximately 350 artefacts revealed what appeared to be two different 'styles' within the assemblage. On the one hand, large and neatly retouched tools, produced out of Rijckholt flint, that are described as technologically similar to Michelsberg assemblages; on the other hand smaller flakes and blades from flint with unknown origin. A number of these blades are used transversally to process reed or grass. This activity is related by van Gijn to the production or repair of baskets and/or fish traps. The scrapers made from Rijckholt flint were used to process hides. The authors underline that these scrapers do not need to imply hide working at the site itself as these fine tools were presumably kept and frequently re-used; a feature often seen in Michelsberg context as well (Schreurs 2005). One large blade may even have been used to clean fish (van Gijn & Verbruggen 1992: 352).

For his Ph.D. thesis Raemaekers (1999: 55-59) analysed 193 flint artefacts[37] in detail (table 6.13)[38]. The number of artefacts per waste layer is somewhat low making this analysis not as representative as one would like.

The 31 artefacts from L30 are 20 pieces of debitage material, 4 tools, and 7 pieces of waste. Most of the flint is of unknown origin (77%), whereas small amounts of coastal flint or Meuse eggs, terrace flint, Rijckholt and Light-grey Belgian flint occur. The material shows mainly no cortex (63%) or exposure to heat (74%). It was observed that flake technology was more common than blade technology (74% versus 26%). Of the fourteen flakes, eight are intact with an average length of 27 mm. The only complete blade out of five has a length of 24 mm. The four tools comprise a trapeze and three retouched flakes. As the trapeze has a length-width ratio of 1.2 it may possibly be of Swifterbant origin.[39]

The 80 artefacts from L50 base are 47 pieces of debitage, 13 tools, and 20 pieces of waste. Again, most of the flint is of unknown origin (73%). Both Rijckholt and terrace flint is used moderately (23%), while Meuse eggs, Light-grey Belgian flint and fragments of polished flint axes occur

36 No beaver bones have been found in layer L30 (Raemaekers 1999: 114, table 3.49).

37 The 31 artefacts of layer L30 are a sample (Raemaekers 1999: 55).

38 As the tools in table 3.22 by Raemaekers (1999: 59) are included under the categories 'flakes' and 'blades' the numbers differ from the table used in this publication.

39 As the exact measurements of the trapeze have not been published, measurements are taken from figure 3.14 (Raemaekers 1999: 56).

Table 6.13 Total number of artefacts per typological category of the site Brandwijk - Het Kerkhof.

	L30	L50 base	L50 top	L60	Total	%
Debitage material					**113**	**59%**
Flakes	14	31	9	23	77	40%
Blades	5	7	2	6	20	10%
Chips	1	6	2	4	13	7%
Cores		3			3	2%
Tools					**22**	**11%**
Scrapers		2	2		4	2%
Borers		1			1	1%
Drop shaped points		2			2	1%
Leaf shaped points		1	1	1	3	2%
Trapezes	1				1	1%
Tools on flake	3	5			8	4%
Tools on blade		2	1		3	2%
Waste					**58**	**30%**
Indet. fragments	7	19	11	19	56	29%
Frost flakes						
Potlids		1	1		2	1%
Nodules						
Total	**31**	**80**	**29**	**53**	**193**	**100%**

once or twice. The artefacts mostly have no cortex (73%) or heat damage (56%). In this assemblage flake technology is even more dominant over blade technology (79% versus 21%). The flakes are divided into 24 complete and 16 damaged specimens, for the blades this is 2 versus 5 correspondingly. The complete flakes and blades have average lengths of 25 mm and 29 mm. Also three flake cores and six chips were found. The tools are defined as two drop-shaped points, one leaf-shaped point, one pointed blade, one borer, two scrapers, five retouched flakes, and one retouched blade. Two points, the two scrapers, and one retouched flake are produced out of Rijckholt flint. Relying on the pictures, the two fragmented scrapers have dorsal scraper fronts with curved delineation and one or two retouched edges. Unfortunately, no debitage axis is indicated.

The 29 artefacts of L50 top are 13 pieces of debitage material, 4 tools, and 12 pieces of waste. The predominant flint type is of unknown origin (66%), Rijckholt is used moderately (24%), and fragments of polished flint axes and terrace flint occur once or twice. Artefacts without cortex are predominantly present (90%) as are unburnt specimens (61%). Debitage is focussed on the production of flakes (67% versus 33% for blades) which have an average length of 25 mm. No intact blades were encountered. The tools consist of one leaf-shaped point, two scrapers, and one retouched blade. The point and one scraper were made of Rijckholt flint. In the pictures, an artefact defined as pointed blade (Raemaekers 1999: 57 fig. 3.14. h) shows more similarities to a horseshoe scraper. This artefact might just be erroneously labelled as the artefact defined as scraper (Raemaekers 1999: 57 fig. 3.14. j) is actually a retouched blade. The other scraper has a distally located, curved scraper front produced on the dorsal face.

The 53 artefacts from L60 are 33 pieces of debitage, 1 tool, and 19 pieces of waste. Most of the flint is of unknown origin (66%). Rijckholt flint is used moderately (23%), whereas terrace flint and Light-grey Belgian flint both occur three times. The material mainly shows no cortex (91%) or exposure to heat (58%). Apparently, flake technology is more common than blade technology (77% versus 23%). Of the 23 flakes, 14 are intact with an average length of 24 mm. Half of the blades are also intact resulting in an average length of 45 mm which is exceptionally large compared to the blades from all the other waste layers. The only tool recovered from this layer is a drop-shaped point.

In conclusion, in all layers flake debitage outnumbers blade debitage. Still, all these artefacts are rather small, except for the blades of layer L60. L30 is characterised by a different arrowhead type compared to all the other layers. In the latter only drop- and leaf-shaped points with invasive retouch occur, instead of trapezes. The absence of polished flint axes may be significant as well, although the generally low number of artefacts should also be taken into account. The augmentation in artefacts without cortex or patina in the successive layers may be related to the increasing amount of imported artefacts of Rijckholt flint, Light-grey Belgian flint, and polished axe fragments. These range from 28%, over 63% and 90%, to 83% of the flint material in the four phases. Again, the low number of artefacts, and especially the low number of artefacts made out of identifiable flint types, may produce an unrepresentative image. Still, the number of imported artefacts increases over time, implying contact with the south, possibly even implying intensified contacts with the south.

Of the stone artefacts recovered from the site no information can be provided as the material has never been published. According to Raemaekers (pers. comm. 2009) the number of stone artefacts is very low, possibly contributing to the absence of a publication.

Thus, the lithic industry largely consists of flint artefacts, at least 350 pieces, and to a much lesser extent of stone artefacts. The pottery is more abundantly present, being 1245 potsherds. As the total weight of the pottery is 26,452 g it largely outnumbers the lithic material in both numbers and weight.

Site function

The preliminary data and the absence of structures[40] make van Gijn and Verbruggen (1992: 352) conclude that the site is most likely not to be interpreted as a permanent or prolonged inhabited settlement, but as a frequently visited camp site that was used for hunting and fishing.

The botanical and zoological evidence presented by Bakels and Robeerst (taken from Raemaekers 1999: 59-61) and by Out (2008) does not contradict this. Bone fragments of pig/wild boar and sheep/goat[41], but also of otter, beaver, and red deer, and countless fish and bird remains, suggest a diversified subsistence strategy of both domesticated and wild animals. The presence of cereal remains such as emmer wheat and naked barely, found only in layers L50 and L60, is also suggestive of the mixed economic function of the site. Yet, as the composition of the bone spectrum does not change much over time, site function probably remained largely the same over the whole length of the occupation. Evidence of both summer and winter animals may suggest year-round occupation of the river dune (Raemaekers 1999: 59) or may signify year-round visits.

Conclusion

Even though the different occupation phases at Brandwijk start a little earlier than the levee sites at Swifterbant, both sites together provide a good insight in the living conditions in two different river basins at a similar time.

Only during the earliest occupation phase were cereals not cultivated. It may possibly even be that no beavers were hunted. The very limited amount of flint artefacts from layer L30 seem to suggest that flake debitage on small, local nodules dominated, that trapezes were still the preferred arrowhead type, and that polished flint axes were not yet used.

During the following occupation phases (layers L50 and L60), the flint material was still largely similar to that of the levee sites at Swifterbant, yet differences start to emerge. Nevertheless, both flake and blade debitage occurs, of which the first dominates. These flakes and blades are still rather small, as are the cores, although a few blades measure up to c. 45 mm. A remarkable difference is the presence of imported southern flint artefacts at Brandwijk which are totally absent at the levee sites of Swifterbant. Yet, the use of local flint they have in common, and polished flint axe fragments. Another large difference is the arrowhead types. In the layers L50 and L60 only drop- and leaf-shaped points occur; at Swifterbant these are trapezes and transverse arrowheads. Some of the scrapers show similarities, such as blank types (blades) and techno-morphology (curved scraper front with retouched edges). Nonetheless, a scraper showing affinities to a horseshoe scraper was found. This tool type, along with the arrowhead types and polished flint axes, is typical of the Michelsberg culture (Cornelissen 1988, Schreurs 2005, Vanmontfort 2006, Lüning 1968, Willms 1982, Schut 1991). Thus, it is clear that Brandwijk, or the Rhine / Meuse river basin, was under the influence of the Michelsberg culture in the period between 4220 – 3820 cal BC, whereas its influence did not reach as far as Swifterbant. This Michelsberg connection has already been pointed out by Louwe Kooijmans (1976) and Raemaekers (1999, 2005).

6.2.7 Hazendonk

General aspects

The research at the river dune site of Hazendonk started quite early in 1963, with large-scale excavations between 1974 and 1976. The trenches were positioned around the dune's body according the orientation of the dune itself. At the eastern end of the dune up to five occupation layers could be discerned divided by intermediate layers with few finds (Louwe Kooijmans 1974, 1976).

The site is characterised by a long occupation history from c. 4000 cal BC up to the very end of the Neolithic around 2000 cal BC (Louwe Kooijmans 1999: 114). The different phases relevant for this research are Hazendonk 1 (4020 – 3960 cal BC), Hazendonk 2 (3900 – 3800 cal BC), and Hazendonk 3 (3700 – 3600 cal BC). Sometimes the phases were characterised by intensive use, whereas in other periods only occasional visits occurred or even abandonment. The presence of an extended broad-spectrum

40 The exception is a row of pointed poles, located at the transition of the river dune to the water, interpreted as revetment.

41 In the text Raemaekers (1999: 59) mentions cattle although this is not included in table 3.49 on page 114.

subsistence, combined with pottery and polished axes from the lower level onward[42], make this site fully Neolithic.

The cultural designation of the pottery from the Hazendonk phases 1, 2 and 3 has been disputed over the years (see Louwe Kooijmans 1974, 1976, 1999, 2005, Raemaekers 1999, Raemaekers & Rooke 2006, Amkreutz & Verhart 2006). Nowadays, phases 1 and 2 are attributed to the Swifterbant culture based on the stylistic and technological aspects of the pottery. The local touch that characterises the pottery from phases 1 and 2 are the reason for its difficult positioning (Raemaekers & Rooke 2006). The pottery from the Hazendonk 3 phase is different enough to belong to a separate cultural identity, the Hazendonk Group.

In the above mentioned publications the other archaeological remains are often addressed, yet in minor ways. The bone material gives evidence of fishing and hunting as predominantly beaver and otter were found, in combination with red deer, roe deer, and wild boar. The presence of low percentages of domesticated animals such as cattle and pig are attested in all phases, as are cultivars. The organic tools mentioned are bone awls and chisels in combination with wooden tools such as a wooden hammer.

Lithic artefacts
In the earliest publication (Louwe Kooijmans 1974) the lithic remains were discussed per trench and not by layer. It is therefore hard to determine which phase the material comes from. At that time, 106 flint artefacts and 6 pieces of stone with traces of use had been uncovered. Most likely more stone artefacts were retrieved but not mentioned as they were not deemed interesting by their lack of traces of use. All in all, the lithic material seems limited in number.

The amount of flint material from Hazendonk phase 1 is described as modest. The industry is based on blades, probably of the large and regular kind as links to the Swifterbant material, as described by Van der Waals, had already been made by Louwe Kooijmans (1976: 257). However, Louwe Kooijmans describes them as "small broken blades with retouch along both edges". He also describes the regular blades at Swifterbant site S2 as "fairly small, regularly shaped blades with a maximum length of only 6 cm" (Louwe Kooijmans 2005: 266). Although the exact number is not given, fragments of polished flint axes are present from phase 1 onwards (see Louwe Kooijmans 1999: 114, 2005bb: 260). Of the material from phase 2 only a triangular arrowhead with surface retouch made out of southern flint is described.

The stone artefacts are even less often discussed. Flat pebble ornaments are the only artefact type to be mentioned. The statement of Louwe Kooijmans (2005: 266) that querns are absent at the Swifterbant sites leads one to suspect that grinding stones were not found in layers 1 and 2 of the Hazendonk site.

Other lithic finds that show similarities to the material found at Swifterbant are a mace-head or *Geröllkeule* (Louwe Kooijmans 2005: 266) and a handful of flint artefacts. The latter were found in presumed association with the Hazendonk phase 3 pottery and include two fragments of polished flint axes, two grinding stone fragments and an anvil.

Site function
During the Swifterbant occupation phases, the site was most likely a hunting camp. The occurrence of domesticated animals and plants point to an extended broad-spectrum subsistence of the people who visited. Because of the small dimensions of the dune, the site cannot have been a permanent agrarian settlement, yet extended stays could be sustained by the resources of the area. Even more, pottery was found, just as a small amount of lithic artefacts and bone tools pointing to a diversity of activities.

Conclusion
Both similarities and differences may be seen between the Hazendonk site and the Swifterbant cluster. Again, the similar choice of the location, i.e. a river dune in a wetland environment which is clearly visible from afar, is confirmed. The same faunal and floral characteristics lead to a similar choice of game and prey. The cultivation of cereals in not presumed, yet an extended broad-spectrum subsistence is attested.

Differences can be seen in the pottery and flint assemblage. Although the importance of regular blades is demonstrated, it is not clear whether two separate debitage systems are present. The presence of the blades is most likely related to the function of the site, just as on site S2 at Swifterbant. The triangular arrowhead may be associated with the hunting activities, yet is of a different type as used at Swifterbant. Clearly a northern and southern style in the flint assemblage is visible, as seen at Brandwijk. The absence of grinding tools during the Swifterbant phases is presumed. Both the site's function, i.e. a hunting camp, and the presumed short character of the occupations, may be related to this absence. Then again, the amount of stone artefacts is by no means comparable to that of the Swifterbant type site, raising questions as to the representativity of the sample at Hazendonk.

42 It is presumed that Louwe Kooijmans (1999: 114) meant polished flint axes.

6.2.8 Urk (parcel E4)

General aspects

The river dune site Urk is located in the river basin of the Vecht. The dune must have been clearly visible in the prehistoric landscape as it protruded up to 4 or 5 m above the surrounding area and was easily accessible by water. The site was discovered in 1991 revealing flint, pottery, and charcoal. The research attested that the top of the dune had recently been ploughed away. After a trial excavation in 1996, it was decided to fully excavate the site in 1997. In total 880 m^2 was excavated of which approximately 20% was sieved over 2 mm meshes (Peters & Peeters 2001).

Both Mesolithic and Middle Neolithic occupation phases are present at the site. The first phase is dated between c. 6700 – 5100 cal BC and is characterised by hearth pits and some flint artefacts, whereas the second phase is dated between c. 4200 and 3400 cal BC and contains the larger part of the archaeological remains. Even though the radiocarbon dates point to a hiatus between both occupation phases, the archaeological remains are intermixed within the occupation layer. Luckily, the dune top vanished under the high groundwater level at approximately 3400 cal BC limiting the Neolithic material to the Late Swifterbant phase.

The excavated features are Neolithic surface hearths, Mesolithic hearth pits, small post holes, and plough marks indicating an arable field. More remarkable is the presence of a small cemetery. A total of eight individuals and two skulls were retrieved. One of the adults was buried with six amber ornaments around the head (see below). Due to the disturbance of the top of the dune and the poor quality of the organic remains, it is unclear whether there would originally have been more graves.

The archaeological remains consist of lithic artefacts, pottery, and organic remains. Most of potsherds have Late Swifterbant characteristics such as the dominance of grit temper and decoration over larger parts of the pot's body. The tempering agent is mainly granite (66%) and to a lesser extent quartz (26%). Some potsherds show affinities to TRB pottery, as is the case on site P14, yet it cannot be defined as 'pure' TRB, more like proto-TRB (Verneau 2001: 93).

The faunal remains are a mixture of wild and domesticated species, mainly being wild boar / pig, beaver, cattle, otter, and sheep / goat. Bones of fish and especially birds are rarely found. Whether this is a true image or the result of the limited sieving, postdepositional processes or even signifies a difference in disposal remains to be seen. The botanical remains also show a combination of wild food plants, such as hazelnuts and wild apples, with domesticated cereals, such as einkorn and naked barley.

Lithic artefacts

The flint material is the largest group of inorganic remains. Their exact number is unknown as not all artefacts have been looked at in the same detail. The analysis by Verneau (2001) firstly entailed a division based on size, with the limit set at 1 cm^2. The smaller material was quickly scanned while the larger artefacts, 6120 in total, were described individually using the same method as on the Hoge Vaart site. For the blades this means the production in a systematic and serial manner, regardless of the 2:1 length-width ratio. The quick scan analysis resulted in an unknown quantity of chips, the exact number not being given in the text, only the bulk weight per category burnt / unburnt is given. The first group weighs 521 g, the second 527.2 g. This must represent a large quantity of chips as the weight of both groups roughly equals that of site S3 which has almost 9000 chips.

The flint assemblage mainly consists of northern flint (79.5%) with a little amount of southern flint (1.5%). Up to 19% of the artefacts could not be defined by raw material type. The quality of the flint is not good with many internal frost fissures. The weathered cortex and windblown patina point towards a procurement site with secondarily deposited material, possibly the boulder clay outcrops, for example at Urk (Verneau 2001: 96).

Heat exposure was calculated for the assemblage as a whole. In total 25% of the artefacts had been exposed to heat. Verneau also made an interesting division (2001: 94, table 46) between broken and intact artefacts. Of the broken artefacts up to 24% had been exposed to heat, whereas this was only 1.2% of the intact specimens.

The debitage material consists of flakes, blades, cores, and rejuvenation pieces. Flakes are the most numerous of all artefact types (55%) (table 6.14). They were most often produced by hard, direct percussion while a set of 31 flakes was detached using the bipolar technique (1% of the flakes). Many hinge, step, and Siret fractures were observed, in combination or not, with crushed butts. A few plunging flakes occur as well. Blades appear far less (14%) and were very frequently broken. For the production of blades indirect percussion was used in combination with a somewhat better type of flint. The only illustrated intact blade measures approximately 35x11 mm; three illustrated blade fragments measure approximately 41x16 mm, 47x11 mm, and 57x15 mm. The presence of ten plunging blades indicates too much applied force compared to the volume and shape of the core. There are few rejuvenation pieces but there are plenty of cores (13%). The latter are almost exclusively defined as flake cores (n: 761 or 98%), the 17 blade cores represent the remaining 2%. Flake cores occur both in northern and southern flint, whereas blade cores exist only in northern flint. Although 17 is a small sample, it appears that for these cores a somewhat better type of flint was selected compared to the flake cores. Both the flake cores and the blade cores confirm the hard direct percussion for

Table 6.14 Total number of artefacts per typological category of the site Urk.

	Number	%		Burnt	%	Tools	Blanks
Debitage material	**5018**	**82%**					
Flakes	1366	22.3%	*40%*	60	4.4%		
Flake fragments	2012	32.9%	*60%*	781	38.8%		
Total flakes	***3378***		***100%***			***391***	***2987***
Blades	78	1.3%	*9%*	3	3.8%		
Blade fragments	759	12.4%	*91%*	222	29.2%		
Total blades	***837***		***100%***			***352***	***485***
Rejuvenation pieces	25	0.4%				1	24
Cores	778	12.7%		93	12.0%	50	728
Waste	**1100**	**18%**					
Indet. fragments	1093	17.9%				191	902
Nodules	7	0.1%				1	6
Total	**6118**					**986**	**5132**

the former type and indirect or direct soft percussion for the latter. Verneau indicates that 39 small flake cores were reduced with the bipolar technique of which seven may even be splintered pieces (ibid: 98). The two illustrated bipolar cores have a lenticular cross section and flake scars running half way or across the whole artefact's body. Under my definition these bipolar cores would probably all be defined as bipolar pieces.

The 986 tools are divided by Verneau into functional categories with typo-morphological subgroups making it somewhat challenging to transpose these subgroups to the typology used in this research (table 6.15). Still, scrapers and retouched blades occur most often (c. 20%), all the remaining categories appear far less (between c. 5% and 0.5%). Flakes and blades of northern flint without bryozoans were mainly used as blanks which were preferred over those made from northern flint with bryozoans; only a handful of tools were made out of southern flint. Of the flakes, 12% or 391 pieces had been transformed into a tool, for the blades this is up to 42% or 352 artefacts. Thus, relatively speaking more blades have been transformed, whereas in real numbers flakes lightly dominate as used blanks. Some tool types are predominantly produced out of one category of blank; arrowheads are mainly made from blades, scrapers out of flakes. The arrowheads comprise 35 trapezes, 7 triangles with surface retouch, 1 leaf-shaped point, 1 C-point, and 1 backed bladelet[43]. The scrapers are mainly made out of flakes (66%), and to a lesser extend out of blades (21%). It appears that the tools on blades are fractured twice as often as those produced out of blades (ibid: 106). Whether this is the result of a difference in function, structural strength, or technical control is debatable. The retouched pieces demonstrate a clear predominance of blades. It was observed that the gloss on some of these blades derives from processing soft plant material (ibid: 106). The definition of the borers, engraving tools, and splintered pieces is somewhat indistinct; however, it appears that no clear burins (produced by the detachment of burin spalls) were recognised. Blanks are more varied than just flakes and blades, while the selection of raw material was also less strict. Moreover, the equal use of northern flint with and without bryozoans is discernible for the "percussion tools" too. No other details are given on the hammerstones or strike-a-lights (rounded pieces); the group of polished axe fragments consists of four flakes and a fragmented specimen,

Table 6.15 Total number of tools of the site Urk.

	Number	%
Scrapers	194	19.7%
Borers	20	2.0%
Engraving tools	21	2.1%
Arrowheads	46	4.7%
Hammerstones	4	0.4%
Polished flint axe fragments	5	0.5%
Rounded pieces	5	0.5%
Splintered pieces	40	4.1%
Tools on flake	27	2.7%
Tools on blade	179	18.2%
Tools on other blanks	9	0.9%
Indet. tools	170	17.2%
Indet. tool fragments	266	27.0%
Total	**986**	

43 In the text only 35 trapezes are mentioned (Verneau 2001: 103), while in the table 36 are listed. The latter is presumed to be correct as a total of 46 projectile points should be present.

of which presumably the latter is produced out of southern flint. Finally, we must not lose track of the fact that the category of indeterminate tools and tool fragments is the largest of all (44%). At least seven of these are small tool edge rejuvenation pieces.

The information on the stone artefacts is very limited as no systematic analysis was undertaken; the exact number of finds is therefore unknown. Peeters (Peters & Peeters 2001: 109) observed that the main part of the stone material consists of granites and that it is characterised by heavy weathering. A few hammerstones have been identified (Peters & Peeters 2001: 109), and two quartzite flakes (Verneau 2001: 95). It is possible that part of the material was destined to be temper for the pottery (Peters & Peeters 2001: 109). Whether the weathering is the reason why only a very limited number of tools were recognised, or whether the low number of tools is an actual fact is unclear. Moisture easily affects granites leading to the weathering of minerals like biotite and eventually resulting in the pulverisation of the rock itself. This highly obstructs typological determinations of possible tools.

Rather rare finds are the six amber ornaments, the only stone artefacts described in detail, recovered from grave 2. The only other Swifterbant location where amber ornaments have been found, in- or outside graves, is Swifterbant itself. The finds from Urk consist of six amber ornaments retrieved from the area around the head of skeleton 3 in grave 2. The poor conservation and the fragmentary state of the skeleton made it impossible to determine the gender of this adult individual (d'Hollosy & Baetsen 2001). Of the two pendants and five beads, only three beads were found in situ on the skull. By analogy with the male burial in Swifterbant, the researchers plausibly suggest that they all belong to a series of beads strung around the head (ibid: 52). The largest ornament is the pendant measuring 30x18x17 mm (*no. 962-1*). It is a naturally formed lump of amber with, presumably, an hourglass shaped perforation. The other pendant is tear-shaped and a lot smaller, only 12x8x8 mm (*no. 962-2*). It is also a natural lump and presumably perforated from both sides. The beads are varying in dimensions measuring from 8x7x3 mm up to 24x13x11 mm. They all have hourglass shaped perforations and a rather flat overall shape. To complete the series, a small chip measuring 3x3x2 mm is mentioned. All ornaments have a dull appearance as the result of bad preservation and oxidation.

As the precise number of flint and stone artefacts is unknown, the proportion between one another cannot be determined. Yet, it is established that the flint artefacts form the largest group of inorganic material (Verneau 2001: 93) and they at least comprise 6118 artefacts. The pottery consists of 5107 potsherds, of which 3078 are smaller than 1 cm² (60%) (ibid: 77-78). The pottery has a total weight of 23,643.1 g while the smaller flint fragments weigh 1048.2 g.

Site function

The presence of all sorts of features and a wide range of archaeological remains all point to the characteristics of a base camp. A small arable field, a cemetery, small post holes, pottery, and flint artefacts indicate the wide variety of activities at this site. Whether small and light structures like huts were present is no longer attestable because of the erosion of the dune top. It is, however, clear that no 'heavy' structures such as on site P14 were built. The animal bones and organic remains signify an extended broad-spectrum economy of gathering, hunting, (and probably) fowling and fishing supplemented with animal husbandry and small scale agriculture. The definition as multifunctional base camp is based on the assumption that all these activities are simultaneous. However, short periods of specialised activities that succeed each other rapidly may also lead to this multifunctional image (ibid: 120-121).

Conclusion

Just as at Emmeloord, the river dune site Urk is located in the river basin of the Vecht. The site is not optimally preserved as the top of the dune was destroyed in recent times, erasing possible features or even post holes. Even more, the material from the different occupation phases is intermixed in the cultural layer. In this way Urk largely resembles the situation at the river dune sites at Swifterbant where Mesolithic and Neolithic material is also intermixed. The presence of hearths, post holes, flint tools, pottery, a cemetery, and possibly a small arable field characterise the site possibly as a settlement site or base camp. The mixture of wild and domesticated animal bones combined with wild and cultivated organic remains point to an extended broad-spectrum subsistence. However the definition as multifunctional base camp is based on the assumption that all these activities are simultaneous.

The dominant use of northern flint of poor quality, gathered from local secondary procurement sites, is again attested. The little admixture of southern flint is most likely gathered regionally, for example at the Utrechtse Heuvelrug or the Veluwe (40 – 50 km) as it is of secondary origin. The presence of polished flint axe fragments, presumably of southern flint, point to the import of these pieces and hint at contacts with the south. For arrowheads, scrapers, and retouched pieces preference was given to northern flint without bryozoans, which was also observed at Swifterbant. The remaining tool types are equally made out of northern flint with bryozoans as northern flint without bryozoans. At the site itself, the flint assemblage is aimed at the production of flakes. They were mainly produced with hard direct percussion and to a lesser extent with the bipolar technique. The regular blades, made of a somewhat better quality of flint, were not all produced at the site. Yet, the use of northern flint suggests a local or regional production. Some are larger than 50 mm indicating their Neolithic origin and resemblance to the regular blades found at Swifterbant. Even though some of the flakes, blades, and tools are of Mesolithic date, most tools are retouched blades and scrapers which are typo-morphologically very similar to the material from Swifterbant. Gloss on some of these blades derives from processing soft plant material, an activity clearly attested at the Swifterbant sites. The arrowheads are dominated by trapezes and a few triangular and leaf-shaped points occur as well.

The stone artefacts are mainly made out of granite. As this material is largely weathered, only a few hammerstones and two quartzite flakes could be discerned. Even as these types of artefacts occur at Swifterbant, it is possible they belong to the Mesolithic occupation phase. As the pottery is mainly tempered with granite, some of the weathered material may be interpreted as temper ready to be used. The use of amber ornaments at Urk is identical to the Swifterbant sites. The selection of natural lumps, altered only with an hour-glass perforation, resemble the pendants and beads from the different sites at Swifterbant (S2, S4 and S22). While morphologically they are alike, the ornaments from Urk are a bit smaller in dimensions although they fit the defined size groups well. As in Swifterbant, one bead is exceptionally large and exceeds the length of 20 mm. More striking is the fact that the ornaments were strung around the head of the buried adult, just as in grave IX at Swifterbant (site S2).

6.2.9 Emmeloord (parcel J97)

General aspects
The site of Emmeloord is known for its numerous fish weirs and fish traps. As the top of this levee site is heavily eroded, the value of the site lies in its creek and its good organic preservation.

The site was discovered in 1950 when the digging of the ditch slopes in the reclaimed land revealed archaeological remains. In this respect, the site was discovered earlier than the Swifterbant cluster. However, based on the potsherds recovered at that time, the Emmeloord site was dated to the Early Bronze Age. Later research, conducted between 1984 and 2001, revealed an extended date and the full potential of the site as many fish weirs and fish traps indicated the excellent organic preservation in the creek alongside the levee (Bulten et al. 2002, Bulten et al. 2009).

Occupation of the levee and activities in the creek started around 3360 cal BC with the construction of the first fish weir. This fresh water creek is part of the Vecht basin and was at its time of use under the influence of tidal activities. This occupation phase ended at c. 3000 cal BC when the dynamics of the sea and creek changed and the fish population diminished. After 600 years, around 2400 cal BC, the sea regained its impact on the creek and both fish and people returned to the site. Finally, the activities ended in the Middle Bronze age at around 1500 cal BC (Bulten et al. 2002: 126).

It is especially the pottery that revealed the cultural designation of the different occupation phases. The first occupation phase[44] belongs to the Swifterbant culture. After the 600 year gap, a continuous range of dates[45] are seen in combination with pottery stretching from the Funnel Beaker to the Hilversum culture.

Research focused on the fish weirs and fish traps, clearly influencing the amount of other archaeological remains. The fish contraptions make up the bulk of the material whereas the bone and wooden artefacts, as well as the pottery and the lithic artefacts, are under-represented.

As the fish weirs and fish traps belong to different periods alterations in shape and construction technique could be observed. Radiocarbon dates linked three fish weirs and two fish traps to the Swifterbant occupation phase. The collected bone tools comprise awls, needles, fish hooks, chisels and spatulas. Other organic artefacts are a wooden rod (Van Rijn 2002: 77), possible harpoons (van der Heijden & Hamburg 2002: 56), a T-shaped antler axe and a beaver tooth pendant (Kerkhoven 2001). The pottery shows a large cultural diversity ranging from Swifterbant pots to Hilversum pots. Up to 15 potsherds presumably belong to the Swifterbant phase. This material is predominantly tempered with quartz and mica and has polished surfaces. Perforations and indentations also have been observed. According to Bloo (2002: 82) these pottery characteristics imply a Late Swifterbant date.

Lithic artefacts
The eroded character of the site has its influence on the analysis of the lithic material as well. Even though some of the Swifterbant pottery could stratigraphically be linked to the fish traps of the Swifterbant occupation, this was not the case for the lithic material. Therefore, it is assumed that most of the material is mixed. A second aspect to consider is the sieving of only a part of the soil over 4 mm meshes and the absence of chips in the typological list used by Verneau (2002), chips are presumably defined as flakes. This impedes the comparison with the Swifterbant material under discussion.

The flint material consists of 6882 artefacts divided into 5091 pieces of debitage (74%), 180 tools (3%), and 1611

44 This phase is dated by wood samples between 4520±30 BP and 4400±20 BP.

45 The dates range from 3850±20 BP to 3450±35 BP. Again these dates come from wood samples gathered from fish weirs and fish traps. The dates from food crusts on pottery are somewhat older, possibly implying reservoir-effect by the cooking of fresh fish (Bulten et al. 2002: 121).

pieces of waste (23%) (table 6.16). The flint types used to produce this assemblage were not recorded during the analysis, although several observations were made by Verneau. Both northern and southern flint was attested; some of the artefacts could, however, not be determined by type. The flint of northern origin largely outnumbers both other groups. It was observed that all material was of rather poor quality with internal fissures and frost flaking. Along with the eroded surface and weathered cortex a secondary procurement site is accepted. The most likely source is the boulder sand and boulder clay deposits in and around the Noordoostpolder. These have outcrops at Schokland, Urk, Tollebeek, De Voorst, Gaasterland, and Vollenhove. Verneau does not discuss the possible procurement sites of the southern flint. The percentage of cortex still present per artefact was not analysed either, although heat exposure was. In total 2259 artefacts (33%) showed traces of discolouration, fire cracking, or potlidding.

Within the whole assemblage the overwhelming presence of flakes can be attested (65%). The division between flakes (62%) and large flakes (3%), based on a boundary of 40 mm, indicates the predominantly small dimensions of these artefacts. The blades only represent 1% of the material found at the site. They are regular and made out of a good quality of flint. In addition, there are no indications of blade production on the site. This is also reflected in the cores which only have flake negatives. Direct, hard percussion was used in a rather randomly fashion to detach the flakes, whereas direct, soft percussion was observed in only a few dozen cases. The cores have one, two, or more striking platforms, all used in a unidirectional way. One core is a fragment of a polished flint axe. It is, however, unknown whether polished flakes from this core occur at the site. As Verneau only mentions one rejuvenation blade, and depicts one rejuvenation flake, it is unknown what the total share of preparation or rejuvenation pieces is. However, Verneau suggests the rejuvenation blade may have been brought to the site, just as the blades might have been.

The information given on the tools is restricted and often limited to a few sentences. They consist predominantly of retouched pieces (59%) and to a much lesser extent of scrapers, borers, arrowheads and strike-a-lights (13% - 5%) (table 6.16). Nearly all of them are produced from flakes. The projectile points are defined as triangular arrowheads with surface retouch and a barbed arrowhead. These types are typical for Late Neolithic / Early Bronze Age contexts, just as the complete Scandinavian dagger. Trapezes, transverse or drop shaped arrowheads have not been found. The other tools are three flint hammerstones, a notched tool (*encoche*), three denticulated tools and two pointed tools (*pic*). Of these tools it is also unclear to which occupation phase they belong.

Table 6.16 Total number of artefacts per typological category of the site Emmeloord.

	Total	%
Debitage material		
Flakes	4265	62%
Large flakes	198	3%
Blades	78	1%
Cores *	550	8%
Tools	**180**	**3%**
Scrapers	23	13%
Borers	12	7%
Strike-a-lights	6	3%
Arrowheads	9	5%
Retouched pieces	107	59%
Other tools	10	6%
Visible use-wear	13	7%
Waste	**1611**	**23%**
Total	**6882**	

* One of these cores is a re-used polished flint axe fragment.

The first step in the analysis of the stone material was the selection between stone fragments without any traces and those with definite traces of production or use. The total of 2336 artefacts was hereby reduced to 26 pieces to be described in detail; this is only 1% of the stone material. As this first step was rather brief and fleeting, some tools may have been overlooked (Kars 2002: 96). It is also unclear whether flakes are seen as artefacts with traces of production or use.

Many different rock types were used for this assemblage, all of which can be gathered from the boulder clay deposits in the Noordoostpolder. Notable is that no other than this boulder clay material was observed. The fragmentation rate is high, possibly due to human factors but also as a result of heat exposure. Kars speaks of hearth and cooking stones (2002: 97).

The 26 selected tools are defined as ten hammerstones, nine grinding stones or fragments thereof, five whetstones, and two axes. Of the ten hammerstones eight are intact and two are fragmented. The intact specimens are mainly cobbles clustering between 53x37x34 mm (99.1 g) and 62x48x48 mm (207.6 g); two exceptions are somewhat bigger being 75x66x72 mm (507.8 g) and 78x66x63 mm (401.2 g). The used rock types are mainly sandstone, whereas quartz, quartzitic sandstone, and granite are used only once or twice. Impact traces are visible on the extremities or all around the sides and the intensity of them may vary. The smallest hammerstone has light traces while one of the bigger ones shows flake scars on an extremity as the result of usage. Some of the hammerstones also show traces of smoothing or even polish and may therefore be defined as combination tools.

Of the grinding stones two complete specimens are described in the text along with seven fragments. Both complete specimens are defined as saddle shaped. They measure 228x185x108 mm and 118x77x45 mm. Only the weight of the first artefact is given (1590 g). Production traces in the form of impact traces and flake scars are clearly visible on the sides of both these granite tools. The seven fragments vary in measurements from 72x43x38 mm (136 g), over 94x118x58 mm (738 g), to 214x140x154 mm (7200 g). Most of these artefacts are made out of granite and have production traces on their sides. Kars defines five of them as parts of netherstones, the remaining two as possibly fragments of handstones. It was observed that the surfaces of the grinding stones have a rather 'fresh' appearance. This makes Kars suggest that, as the area was rich in boulders, this site might have been used as a production site for grinding stones ready to be exchanged.

Kars defines the whetstones as a separate category "based on shape, size, and function" (Kars 2002: 102), but fails to give specific definitions. Therefore it is unknown how much they differ from the grinding stones. As all the grinding stones are said to be saddle shaped, the whetstones are presumably artefacts with a smoothed or polished surface of a different shape, that is non-saddle shaped. The raw material used is sandstone, quartzitic sandstone, and quartzite. Two artefacts are intact measuring 111x65x75 mm and 175x160x140 mm. The first may have been used as a grinding stone (handstone) and the second is special because of two unusual and round pits[46] of 30 to 40 mm in diameter. The first hole is smoothed in- and outside the indentation; the other is presumably a natural indentation but with smoothing traces only inside the hole. A possible function proposed by Kars is that of polishing bone awls and needles (Kars 2002: 102).

Finally, two axes are described. The first one is a complete specimen measuring 76x54x26 mm and is made from dolerite. Exceptional is the asymmetric cross section. According to Kars (2002: 97) this is the result of the re-sharpening of the cutting edge. Still, this alteration cannot obscure the original shape of this flint axe with oval cross section (*Fels-oval*). The second axe is damaged at the butt. The fragment still measures 103x60x34 mm and is made of granite. The axe has one oval side and one rectangular side making it a form between *Fels-oval* and *Rechteck-beile*. Due to the fragmentation of the butt its original shape, pointed or *dünnackig*, cannot be determined.

Thus, the lithic industry is made up of 6882 flint artefacts (75%) and 2336 stone artefacts (25%). However, it is unclear how many of these belong to the Swifterbant occupation phase. A total of 1638 potsherds were found, of which c. 360 (22%) are smaller than 4 cm². Yet, only 15 potsherds, or 1% of the total amount of pottery, could be defined as Swifterbant pottery. If we apply this hypothetically to the lithic artefacts, possibly 68 flint artefacts and 23 stone artefacts would belong to the Swifterbant occupation phase, both outnumbering the amount of pottery.

The comparison of weight hardly provides any more useful information as the weight is given for the bulk of the material. The pottery weighs 21,273 g, while the flint and stone artefacts weigh c. 37,480 g and c. 175,000 g respectively.

Site function

That this site was a fishing camp is not only confirmed by the presence of numerous fishing contraptions and fishing tools but also by the large amount of fish bones. The bones of wild mammals such as wild boar, beaver and otter, and bird bones also indicate hunting and fowling at the site whereas the occurrence of cattle, pig, and sheep/goat indicate an equal importance of domesticated animals in the diet. The presence of this extended broad-spectrum subsistence combined with the large variety of flint and stone artefacts, which include debitage material and multiple tool types, point toward a wide range of activities at the site. The importance of fishing cannot, however, be underestimated. Whether the occupations are a string of extended stays or whether it had a more permanent character cannot be attested as the top of the levee, the location where huts would have been built, has been eroded away. The possibility is that people from neighbouring areas regarded this site as their primary fishing ground. Yet, the question remains whether the excellent preservation and the extensive research in the stream gully might over-represent the importance of the fishing activities compared to some of the other special activity camps studied here.

Conclusion

The site of Emmeloord is in a similar geomorphological setting to the Swifterbant cluster. Even though it is located only 15 km away, the levee site is part of the Vecht basin and not of the palaeo-IJssel river system (Cohen et al. 2009). Yet, faunal and floral remains suggest identical living conditions. The research of the heavily eroded site has focussed on the numerous fish weirs and fish traps, limiting the amount of recovered lithic artefacts and other archaeological remains. Yet, the amount of lithic artefacts is not to be neglected, especially compared to some of the other Swifterbant sites studied here, suggesting an intense and/or long use of the site, and possibly indicating something more than a fishing camp. However, as the lithic material could not be defined stratigraphically, the artefacts may belong to the Swifterbant culture or to other Neolithic or Bronze Age cultures. The conclusions are therefore of a general nature.

46 Kars speaks of holes *(twee vreemde ronde gaten)* but presumably means more pit-like features. However, this cannot be substantiated as no whetstones were depicted.

The flint industry was mainly made of poor quality northern flint, gathered locally from the boulder sand and clay outcrops in and around the Noordoostpolder. Thus, similar procurement sites as were used at Swifterbant but possibly flint of a lesser quality. What is different is that some southern flint was observed as well. On the site of Emmeloord, only flake production occurred, organised in a rather randomly fashion. It seems people did not have high demands of the locally gathered flint and on site produced tools. It even appears that the few 'imported' regular blades, carefully produced from a better quality flint, were not preferred above randomly produced flakes to create everyday tools at the site. Whether this was so for the Late Swifterbant phase, or is the result of the Late Neolithic and Bronze Age occupation is hard to determine. The number of tools is considered to be rather low. As the arrowheads are presumably all attributable to the Late Neolithic and Bronze Age occupation phases, the other tools, and presumably also a large part of the knapping material, may be as well.

This most likely also accounts for the stone assemblage. Unfortunately, only a fraction of the recovered material was defined as being used, limiting the amount of material to be compared. Still, the rock types used are restricted to boulder clay material, which is different from the flint artefacts where southern material also occurs, even if it is in small numbers. The stone tools consist of hammerstones, grinding stones, whetstones, and axes. For the hammerstones, mainly made of quartzitic sandstone, naturally shaped cobbles that lie comfortably in the hand were used. The intensity of the impact traces varies, just as their weight, implying both hammerstones and *retouchoirs*. Furthermore, it is unknown how much of them are combination tools. Kars just mentioned that some of them have smoothed to polished surfaces. Therefore some of them might be used as handstones in hammer / grinding stone combinations. This would also explain the low number of handstones found at Emmeloord, although the preliminary nature of the research might have influence in the matter as well. Nonetheless, the characteristics show clear similarities to the tools used at Swifterbant. The grinding stones and the fragments thereof, mainly produced out of granite, are all heavy, implying netherstones. They might be shaped, proven by the flake scars and impact traces on the sides, but this might also be the result of debitage or deliberate fragmentation as observed at the Swifterbant sites. Yet, they are defined as saddle shaped, and thus are clearly different from the specimens at Swifterbant where the natural shape is mostly maintained. The whetstones most likely would be defined as grinding stones by this research's standards. The artefact with two pits may even be some sort of "mortar", as seen at Swifterbant. Then again, the smoothing traces inside the indentations, a characteristic not observed at Swifterbant, might indeed point to an implement to polish bone tools as suggested by Kars. It is uncertain how many artefacts belong to the Swifterbant phase but a part of the tools is in concordance with the material recovered at the Swifterbant sites. Only the saddle-shaped grinding stones, and all their fragments for that matter, may be of Late Neolithic or Bronze Age occupation phases as saddle-shapes are not seen at Swifterbant. The whetstone may very well be 'Swifterbant type' grinding stones, although this cannot be confirmed with certainty. Axes with an oval cross section (*Fels-oval*) are traditionally dated to the Early Neolithic but a longer use such as the Middle or Late Neolithic cannot be ruled out (Bakker 1979, Beuker et al. 1992, Drenth 2005: 341). The *Fels-Rechteck* axes are dated to the Middle and Late Neolithic (Beuker et al. 1992: 117). That these two axes belong to the Swifterbant phase is therefore a possibility, though yet not a certainty.

6.3 The Swifterbant culture: a general overview

6.3.1 Introduction

The Swifterbant culture forms the start of the neolithisation process in the Pleistocene coversand regions and adjoining Holocene areas between the rivers Scheldt and Elbe. The area encompasses large parts of the Netherlands and neighbouring parts of Belgium and Germany (Raemaekers 1999). The most distinctive feature by which all sites are characterised is the typical S-shaped Swifterbant pottery.

Based on new pottery research Raemaekers (2003/2004) divides the Swifterbant area into three cultural spheres. These three spheres or regions do not only have specific characteristics expressed in their pottery, they also have different time dynamics, i.e. not only the date the Swifterbant culture was introduced in that region but also its demise. These three cultural spheres are related to the river basins in which the different Swifterbant sites are located. In the north the river basins of the IJssel/Vecht/Eem form one cultural sphere. The sites from this region analysed in this study are Hoge Vaart, the Swifterbant cluster, Emmeloord and Urk. The second river basin located more to the south is formed by the Rhine and Meuse. Known sites are De Bruin, Polderweg, Brandwijk, and Hazendonk. The third and most southern group, located in the Scheldt basin, is characterised by only one site, Doel.

This general overview will only lightly touch upon the upcoming topics, as detailed discussions on these topics have already been published in detail by others. It merely sketches a background against which the technological developments of the lithic industry should be outlined.

6.3.2 *Time frame*

The Mesolithic (c. 8000 – 5000 cal BC)
Evidence of occupation from the Late Mesolithic into the Swifterbant period has been attested in the Netherlands and Belgium. From the river systems of the IJssel/Vecht/Eem in the north to the river system of the Scheldt in the south occupation was continuous. Yet, not all sites currently known were as frequently visited as some others.

The occupation at Swifterbant started in the Middle Mesolithic. The river dune sites were occupied in several different phases between c. 6685 and 4990 cal BC. Currently, the oldest occupation is represented in trenches S21-S24. This dune appears to have been occupied most often in the Mesolithic but also shows clear traces of Neolithic occupation. These frequent visits resulted in the largest accumulation of flint artefacts of a river dune at Swifterbant suggesting the popular character of that specific dune[47]. At one point in time, between 5300 and 5100 cal BC occupation at four different river dune sites was established, being S11, S23, S61, and S83.

Middle and Late Mesolithic occupation was also attested at several other Swifterbant sites to the south. These are De Bruin (5500– 5100 cal BC), Polderweg (5400 – 5200 cal BC), and Hoge Vaart (6650 – 5000 cal BC). The Mesolithic occupation at Doel (8000 – 7500 cal BC) dates to the Early Mesolithic.

The Early Swifterbant Phase (5000 – 4600 cal BC)
The earliest Swifterbant occupation is in the Rhine/Meuse river systems. Polderweg (5200 – 5070 cal BC / phase 2) has the first traces of the typical S-shaped Swifterbant pottery. Shortly afterwards is the occupation at De Bruin (5030 – 4940 cal BC / phase 2).

Roughly in the same period, the IJssel/Vecht/Eem river systems are occupied as well. The site Hoge Vaart has two separate occupation phases, of which one in the Early Swifterbant phase (4950 – 4500 cal BC / phase 3).

An intermezzo
At the transition of the early to the middle Swifterbant phase, a development was set in motion at the Rhine/Meuse river systems' site De Bruin (4700 – 4450 cal BC / phase 3). After the inundation of the river dune at Polderweg, occupation shifted back again to De Bruin at which time the adoption of animal husbandry is the first sign of the upcoming change in the subsistence strategy.

The Middle Swifterbant Phase (4600 – 3900/3800 cal BC)
It was only at this middle stage of the Swifterbant culture that the Scheldt river system appears to be inhabited by the Swifterbant people. New dating evidence places the occupation of the site Doel at 4550/4500 – 4000 cal BC. Even though the radiocarbon dates place the occupation at Doel in the Middle Swifterbant phase, the site only has characteristics of the Early Swifterbant culture like the exclusive gathering of wild resources and the absence of domesticated food products. The material culture also shows only traces of Early Swifterbant characteristics, especially in the morphological and stylistic features of the pottery but also in the use of microliths as projectile points. This might imply a delaying effect in the spread of the Swifterbant culture or a difference in cultural preferences.

The most famous Middle Swifterbant site is located in the river systems of the IJssel/Vecht/Eem, namely that of the Swifterbant type site itself. The site is formed by a cluster of occupied areas defined as site S51 (roughly 4360 – 3800 cal BC), site S4 (4350 – 3970 cal BC and 3700 cal BC), site S3 (4330 – 3950 cal BC), and site S2 (4250 – 4000 cal BC). All these are levee sites. Yet, the river dunes in the area all show occupation in the Mesolithic as well as in the Swifterbant period. Radiocarbon dates reveal occupation in trenches S21-S24 (4500 – 3950 cal BC), on site S61 (4500 – 3800 cal BC), and sites S80-S82 (5370 – 4990 cal BC).

At the same time, the site of Hoge Vaart is also occupied again (4350 – 4050 cal BC / phase 4).

In the Rhine/Meuse river systems, the middle phase of the Swifterbant culture starts slightly later. For example, the site Brandwijk is occupied in three phases (4220 – 4100 cal BC / base layer 50, 4030 – 3940 cal BC / top layer 50, and 3940 – 3820 cal BC / layer 60). At Hazendonk two different occupation phases have been discerned (4020 – 3960 cal BC / Hazendonk 1, 3900 – 3800 cal BC / Hazendonk 2). By the time of the Hazendonk 3 occupation, the culture had evolved into a separate identity (3700 – 3600 cal BC), the Hazendonk culture.

The Late Swifterbant Phase (3900/3800 – 3400 cal BC)
By the time of the late Swifterbant culture the Swifterbant territory seems to be shrunk all the way to the north. This evolution starts in the south, in the Scheldt river system. At roughly 4000 cal BC the Michelsberg culture replaces the Swifterbant culture and creates a sudden change to a Neolithic way of life. In the Rhine/Meuse river systems the evolution to the Hazendonk culture meant the end of the Swifterbant culture at roughly 3700 – 3600 cal BC. Only in the river systems of the IJssel/Vecht/Eem did the Swifterbant culture linger on. The sites analysed in this study are Urk (4200 – 3400 cal BC) and Emmeloord (3360 – 3000 cal BC).

47 This observation is by absence of large scale excavations at sites S80-S84.

6.3.3 Site location

One of the main aspects the different Swifterbant sites have in common is their uniform setting in the landscape. It seems their distribution is based on the natural settings of the area, i.e. floodplains and estuaries as all sites are wetland sites characterised by an (somewhat) elevated position and easy access to open water. Whether they are river dunes (De Bruin, Polderweg, Brandwijk, Hazendonk and Urk), coversand ridges (Hoge Vaart and Doel) or levees (Swifterbant and Emmeloord), their position and possibly vegetation make them stand out in the surrounding area. This suggests the preference for visible, high and dry places, with easy access to open water, is persistent throughout the three phases of the Swifterbant culture. Nonetheless, there are some indications for the use of landscape zones under wet conditions.

These protruding areas combine characteristics of two different geomorphological features providing the best of both worlds. On the dunes deciduous trees would not only have provided the necessary wood but would also have offered shelter from the wind to the settlement located on the slopes of the dune. The wetland area around the site would have provided all the important resources that backswamps and rivers could give.

It has been argued that, as they all are wetland sites, the representativeness of their economic subsistence base may be questioned (Raemaekers 1999). However, as the wetland sites contained numerous drier elements like these river dunes, coversand ridges and levees, and the upland areas are dissected by many small streams and larger rivers (Raemaekers 1999: 112-113), the difference is probably one of degrees or proportions and not one of exclusiveness and exclusion. Since the discovery of small arable fields at Swifterbant (Huisman et al. 2009, Huisman & Raemaekers in prep.) the conviction that the wetland sites would be too small and too wet to sustain cereal cultivation is dismissed. Therefore, it is very likely that all aspects of the subsistence strategy may have been applied both in the wetland as in the upland areas, yet maybe in different proportions.

6.3.4 Site function and seasonality

As these two aspects can only be determined by the archaeological remains present at the sites, activities that leave no archaeological traces will be hard to attest. The same applies to seasonality. Different occupations at different times of the year may give the suggestion of year round occupation. Yet, when all aspects of archaeological research have been combined with the organic and inorganic find categories a clear image may emerge.

Both Polderweg and De Bruin are interpreted as settlement sites or base camps. Extended stays in these semi-annually inhabited settlements are suggested by the presence of huts, made out of wooden posts with dug out floors, and the production waste of many and different types of tools. As the archaeological remains on these twin sites are very alike, the activities preformed at the sites must have been similar too.

Another story are the sites Hoge Vaart, Brandwijk and Hazendonk. The first site is believed to be an accumulation of numerous small hunting camps. Each consists of a single hearth and is characterised by flint production oriented on archery and butchery. Hoge Vaart is thus not a residential base camp or settlement site. Yet, the presence of pottery production suggests periods of extended stay, at least to some extent. Brandwijk is interpreted as a frequently visited hunting and fishing camp. As evidence of both summer and winter animals have been found, these frequent visits must have been year-round. No huts were attested, only a row of pointed stakes interpreted as revetment or a small palisade. The archaeological evidence at Hazendonk, located halfway between Polderweg / De Bruin and Brandwijk, suggests the site was used as a hunting camp. The presence of all kinds of tools, such as bone awls, chisels and even a wooden hammer, points to different activities and maybe even to prolonged stays, even if the site is believed to be unable to sustain a permanent agrarian settlement due to its small size. However, the levee sites at Swifterbant prove that a small site can sustain extended periods of stay when they are located closely together.

Thus, these hunting and fishing camps may be seen as special activity sites, not to sustain permanent settlement but to allow specific activities limited to a certain period of time. However, this certain period of time may have had the form of an extended stay during which the site's function probably stayed the same. These sites form favoured fishing spots and hunting grounds for settlement sites nearby. They may have been visited for a full season or for shorter, frequent stays throughout the year, when fishing or hunting specific targeted prey is at its best. At Swifterbant all seem to be integrated in one area.

The elevated position of the river dunes and the easy access to open water is possibly what made the Swifterbant area so attractive. Yet, Neolithic habitation occurred mainly on the smaller levee sites. On nearly all the levee sites that have been studied so far, traces of occupation have been attested. Yet, the archaeological remains suggest that not all levees were used for the same purposes and that some activities were performed in other intensities at the different sites.

Site S3 is interpreted as the main settlement site. The site is characterised by a house, clay hearths, and large amounts of organic and inorganic archaeological remains. The zoological material comprises bone and antler tools and animal waste.

Site S4 seems to be closely related to site S3. Although the site was firstly used as a hoe-field, the main occupation phase is characterised by lithic finds and pottery, in combination with several types of plant remains and large amounts of animal bones. Other features in common with site S3 are the presence of wooden posts and hearths. One feature on which they clearly differ is the child's grave on site S4.

Both sites S2 and S51 have an isolated position in the river system. It appears they were used as special activity sites, focussing on the use of grinding stones and regular blades, instead of settlement sites. Even more, the cemetery at site S2 clearly signifies a function not present at site S3. However, this is a function it shares with site S4. Whether a cemetery was present at site S51 can no longer be attested due to its eroded character.

Another difference between sites S3 and S4 on one hand and sites S2 and S51 on the other is the large amount of pottery, in comparison to that of stone and flint, on the latter sites.

The mutual relation, between the high amounts of pottery and grinding stones, in combination with regular blades and burials, is not fully understood. Whether the presence of large amounts of pottery is related to some sort of burying ritual or to activities related to the grinding stones, i.e. food processing, is open to debate. They may all be intertwined, or may all suggest different and separate activities.

Because of their eroded and disturbed character Urk and Emmeloord are less easy to interpret. At Emmeloord, the excellent organic preservation of the archaeological remains in the creek, combined with the applied excavation technique, resulted in a limited recovery of pottery, lithic artefacts and other 'house-hold waste'. Therefore, Emmeloord is known for its fish weirs and fish traps, and is thus first of all seen as a fishing camp, whereas less attention is paid to other activities. Yet, bones of wild and domesticated animals, combined with organic tools such as awls, needles, fish hooks, chisels, spatulas, possibly even harpoons and a beaver tooth pendant indicate a wide range of activities. Whether the occupation was a string of extended stays or whether it had a more permanent character cannot, however, be attested.

The same applies to Urk where the eroded dune top may have erased possible features or even post holes. The presence of hearths, post holes, flint tools, pottery, a cemetery, and possibly a small arable field characterise the site as a settlement site or base camp. The mixture of wild and domesticated animal bones combined with wild and cultivated organic remains point to an extended broad-spectrum subsistence. However the definition as multi-functional base camp is based on the assumption that all these activities are simultaneous.

6.3.5 Subsistence strategy

The main characteristic of the subsistence strategy is the evolution from a broad-spectrum economy to an extended broad-spectrum economy. The acquisition of new techniques and resources seems to be a characteristic of the Swifterbant culture. One of their most basic entities, i.e. the acquisition of the technique of making pottery, is indeed a technical innovation attainment by acquisition and assimilation.

The subsistence strategy started out from their fully Mesolithic ancestry of a broad-spectrum economy, i.e. using the full potential of what nature has to offer ranging from gathering wild floral food resources to hunting, fishing and fowling faunal resources. Both larger mammals such as wild boar and red deer, as well as smaller animals such as beaver and otter were frequently hunted, whereas elk, roe deer and seals would have complemented the diet (Zeiler 1987, 1997). As most animals were hunted for their meat, fur and other materials, marten and wild cats would have been hunted for their fur (Louwe Kooijmans 2001a, 2001b). At Polderweg, De Bruin, Hoge Vaart, and Doel subsistence strategies were still fully based on wild resources. It is a good representation of what is known as the "ceramic Mesolithic".

Later, new domestic species were added to the menu. First to be introduced were cattle, sheep and goat (c. 4600 BC), the last to be introduced was pig (c. 4200 BC) (Raemaekers 2003: 742, Raemaekers 2005: 261, 277). Yet the importance of wild food resources remained as it often formed up to 50% of the diet.

These shifting subsistence strategies did not leave the other cultural aspects untouched. During the third occupation phase of De Bruin (4700 – 4450 cal BC), the first site where animal husbandry was introduced, several depositions of pottery and domesticated animals may point towards changing votive and/or cultural practices. At Hoge Vaart, three flint deposits have been found in the swamp at the outskirts of the site. A similar feature may have been found at Swifterbant (site S4). The question remains, however, whether this flint deposit at Swifterbant should be interpreted as ritual deposit or as a cache.

The final stage in becoming fully Neolithic is set at c. 4200 cal BC. At that time, subsistence had switched from a broad-spectrum economy to an extended broad-spectrum economy, combining wild and domesticated food resources, both floral and faunal. The steps tentatively taken at De Bruin and Brandwijk (layer 30) were limited to animal husbandry alone. Now at Swifterbant, and from that time onwards, a variety of domesticated animals combined with newly introduced cereal cultivation of naked barley and emmer wheat is present at the sites. The preference of one animal species above another may have been different per site, as the function of the site may have been different as well, yet the same overall spectrum was hunted and killed, i.e. pig/wild boar, cattle, sheep/goat, with otter/beaver and red/roe deer, in combination with fish and birds.

6.3.6 Organic remains

All sites show a diversity of organic and inorganic tools indicating a varied toolkit for performing all sorts of activities. Organic tools and other supplies are made from wood, bone and antler, such as antler and bone axes in a wide variety of forms, bone awls and chisels, beaver and boar teeth chisels, animal teeth pendants, wooden bows, hafts, paddles, spears, fish traps, fish weirs, and even canoes. These wetland sites have excellent preservation conditions preserving wooden poles, stakes and even pieces of wattle or wickerwork and bast rope.

The evolution in the use or disuse of specific tool types can be exemplified by chisels. It appears that beaver and boar teeth chisels are used in the early stages of the Swifterbant culture, for example at De Bruin and Polderweg. As they no longer appear at sites where animal husbandry is attested, a relationship between the upcoming animal husbandry and the decline in the use of (wild animal) teeth chisels may be suspected. By Louwe Kooijmans et al. (2001: 360) this evolution is seen as the end phase of a typical Mesolithic tradition. These organic tools were replaced by specimens made out of stone like adzes and axes (ibid: 358) over even stone flakes.

6.3.7 Pottery

The main characteristic of the Swifterbant pottery is the S-shaped profile, in combination with the pointed, round, or flat bases and a coil built construction technique. The type of temper is varied, as is the decoration, and is related to spatial and chronological elements.

At the beginning of the Swifterbant culture the pottery consists of S-shaped pots without pronounced profile transitions. Grit is predominantly used as temper, whereas coil-building was mainly done by H-joins. The appliance of decoration is limited to the top of the rim (*Randkerbung*) and knobs may be observed. The pottery at Hoge Vaart and Polderweg form the exceptions, as organic temper has been observed at both sites, and body decoration occurs only at the latter.

During the middle Swifterbant phase the S-profile develops into more pronounced neck-shoulder transitions and organic material becomes the most important tempering agent. Rim decoration is more widespread and varied, while body decoration now occurs regularly. At some sites, pottery with Michelsberg affiliations can be found, especially in the middle of the Netherlands.

In the late phase the S-profile still remains, while a new feature, the funnel-shaped rim, is introduced. The pottery is again mostly tempered with grit, although organic material does not disappear completely. Rim and body decorations become sparser and less varied. A few potsherds show some TRB affinities, yet 'pure' TRB pottery is not found.

Besides these general characteristics (see Raemaekers 1999, de Roever 2004), more regional features have been observed as well. Recent research revealed (Raemaekers 2003/2004) that these are to be divided into three cultural spheres bound by the geographical borders set by the three river systems earlier discussed. Especially tempering agents and decoration style seem to differ. These differences present themselves during the earliest stage of the Swifterbant culture, yet in small proportions. In the middle phase they clearly manifest themselves, while in the late phase the territory shrunk to the IJssel/Vecht/Eem river systems and only one style remains.

In the Scheldt river system the pottery is set apart by the presence of rim perforations, the dominant use of grog as a tempering agent, and the near absence of wall decoration (Bats et al. 2003, Crombé et al. 2002, 2004).

The pottery of the Rhine/Meuse river basins is characterised by the early start and importance of body covering decoration, especially fingertip/nail impressions, and the continuous dominant use of plant temper. Grog as a tempering agent may be observed as well. Rim decoration is less frequent in this region and consists almost exclusively of spatula impressions. The absence of pointed bases and lugs may be attested.

In the IJssel/Vecht/Eem river systems the pottery is characterised by the presence of pointed bases, the importance of rim and shoulder decoration which is rather varied in style and location, the occurrence of lugs, and the continuous dominant use of grit temper. The presence of body decoration is, however, less common whereas grog temper is nearly absent (Raemaekers 2003/2004).

Thus the differences in the pottery between Doel and the northern sites of Polderweg and De Bruin, but also Hoge Vaart, may suggest a difference in spheres of influence. Although a strong morphological resemblance and a parallel of stylistic features between the pottery of Doel and the pottery from the Netherlands exist, the tempering with mainly grog or *chamotte* and organic material differs clearly from all other Early Swifterbant sites which are usually tempered with grit of white quartz and red feldspar. Whether this is related to the absence of suitable stone material near Doel or whether this is a stylistic difference remains to be seen. As the excavations at Doel yielded nearly no stone artefacts at all, the first hypothesis is tentatively preferred; although the second hypothesis may not be overruled either as grog temper is attested in the Netherlands during the middle Swifterbant phase.

6.3.8 Stone industry

Very little is known of the stone industry during the first phase of the Swifterbant culture as not that many stone artefacts have been found at the different sites. The only exception is De Bruin where stone artefacts seem more abundantly present than at the other sites. Between 5040 and 4850 cal BC (occupation phase 2) the tools predominantly consist of hammerstones; only small amounts of grinding stones, arrow shaft polishers, and one anvil have been found. Grinding stones are often seen as Neolithic tools for processing cereal. But as cereal was not yet cultivated by the Swifterbant people at that time, the grinding stones may very well have been used to process all kinds of wild plants and food stuffs, or even used for household activities. At De Bruin, the tools are almost exclusively made from different types of quartzite. This is largely the result of the preference of using pebbles and boulders of different types of quartzite for hammerstones, a preference still existing during the middle phase. One fragment of radial pyrite was recovered as well. Most of the raw material can be found in the Meuse basin, the Meuse and Rhine deposits in the middle of the Netherlands, or even at the Utrechtse Heuvelrug or the Veluwe. These are located up to 40 to 60 km away from the site, thus within the year territory of the Swifterbant people.

Another site inhabited during the early Swifterbant phase is Polderweg. The only stone artefact retrieved from the Swifterbant cultural layer is a quartzite stone without any traces of usage. This ecofact may have come from the Meuse basin. The preference for different types of quartzite seems to linger throughout the whole Swifterbant culture as it is also seen at Emmeloord and Urk.

Also at Hoge Vaart stone artefacts are present in only very small amounts. The material mainly consists of crushed white quartz and red granite, probably to be interpreted as temper for pottery production, a characteristic also observed at Swifterbant. Other artefacts are flakes, fragments, and tools such as an arrow shaft polisher, hammerstones, and a possible chopping tool. The question remains, however, whether these tools, and some other of the stone artefacts, are Mesolithic or Neolithic in origin.

After the abandonment of Polderweg, habitation shifted to De Bruin again (occupation phase 3, 4700 – 4450 cal BC). The adoption of animal husbandry is the first sign of the upcoming change in the subsistence strategy, yet in the stone industry, few or no changes are yet observed. Even if in this phase stone artefacts are present in smaller amounts, the stone artefacts are still more abundantly present than at Polderweg. It seems stone artefacts were always more important at De Bruin than at Polderweg. The dominance of different types of quartzite is still attested at De Bruin, implying similar procurement areas. The lower number of artefacts is paralleled in the lower number of tools. Yet, the tools, being 3 hammerstones, 1 grinding stone, and 1 anvil, form the same percentage within the total amount of artefacts as in the previous phase, that is 3% in this phase against 2% in the previous phase. Looking at the toolkit's composition, it seems that the dominance of hammerstones is more pronounced in phase 2. Yet, the low number of tools in phase 3 might somewhat distort the percentages. Use-wear analysis revealed multiple functions per tool category. Hammerstones were not only used in their strictest sense but also as pestles for the crushing of red ochre or oil-yielding seeds. Hammerstone / grinding stone combinations and even a hammerstone / grinding stone / anvil combination were observed. In addition, it must be mentioned that the stone artefacts are, compared to Polderweg, much more fragmented and mostly weigh less than 20 g (86%). Whether this is especially so for the stone artefacts from the first phase, when flint chips occurred in large quantities as well, is unknown. Stones heavier than 100 g are rare, while only one artefact over 2000 g was encountered.

This research has gathered much information on the middle phase of the Swifterbant culture. At the Swifterbant type site the stone tools comprise grinding tools, polishers, anvils, hammerstones and *retouchoirs*, and combinations thereof, made on cobbles and pebbles with two opposing flat surfaces or triangular cross sections. The blanks used for these tools are rounded specimens that comfortably lie in one's hand and that can be used without any alteration. However, some were altered by minor flaking, or were used as cores or even deliberately destroyed. The latter is especially so for the grinding stones. With the addition of polished axes the stone tool kit is complete. The fair amount of debitage material, mainly flakes, was used in a very limited way as blanks for retouched tools, but their large number suggests they may also have been used unaltered or may have been the base material for temper production.

As no stone material naturally occurs in the soil of the Swifterbant area, all raw materials had to be brought to the site. This strain on the supply of raw material might have urged the Swifterbant people to re-use tools, a characteristic often observed. The primary source for stone artefacts is the boulder clay deposits. The outcrops of Urk and Schokland, at a distance of 10 and 14 km, are postulated as the most likely procurement areas. The Veluwe and the Utrechtse Heuvelrug are a supplementary yet well considered source of southern stone material. All four areas are characterised by a wide variety of rocks with different sizes, shapes and mineral composition. However, the stone artefacts recovered at the Swifterbant sites are limited in their variety of size and rock type which clearly indicates selective collection. Typical of the cobbles and pebbles from the boulder clay are their round shapes with naturally rolled surfaces and rounded edges. These are the rocks that were clearly preferred. Other criteria are size and weight, shape, and rock type. Presumably stones were chosen with a specific function already in mind.

Hammerstones are predominantly made out of different types of sandstones and quartzites (76%). Both pebbles and cobbles were employed as tool blanks as they form two separate weight groups, c. 30 g to 100 g and c. 200 g to 300 g. This dichotomy between the two groups is explained as a difference in function. The hammerstones were used for heavy duties while the *retouchoirs* were used for lighter work.

For anvils different types of sandstones and quartzites (53%) were preferred, with granite or gneiss (35%) used less often. Several different weight classes have been attested, ranging from c. 100 g to 800 g, yet only two basic shapes were observed, namely cubic and pyramid shaped. The intensity of the impact traces, as well as the depth of the anvil pits, also differ per artefact. Therefore, it is believed that the anvils were not only used for flint knapping, either for support during retouching or during bipolar debitage, but also for the production of temper and the processing of food, plants, colourants and other mineral substances.

For the production of grinding tools different types of sandstones and quartzites (44%) were used but also granites and gneisses (35%). The dominance of sandstones and quartzites is most likely related to the compactness of the material which loses fewer minerals when used resulting in a better quality of processed food. The alignment of the grinding orientation with the bedding of the raw material, as observed for gneisses, presumably has the same function.

When multiple working surfaces occur, for example the upper and the lower surface of a tool, these are always used in different intensities. A difference in use intensity between the working surfaces of grinding stones and polishers is observed as well, possibly pointing to a different or less intense use, or even a different, less abrasive, contact material.

Some handstones have a deep pit in the middle of the working surface. It was argued these would 'capture' the food or cereal instead of pushing it to the edges of the netherstone. The younger saddle querns avoid this problem by having a pronounced concave surface. As the Swifterbant netherstones lack any form of modelling, this pit may be a technical ingenuity to increase the tool's efficiency.

Not only does the weight of a handstone offer information on its function, being between c. 60 g and 200 g, its related size may provide it as well. A small pebble seems rather insufficient for grinding large amounts of seeds or cereals but it is rather effective to polish pottery or rub hides. Residue analysis is another complementary source of information. It was observed that netherstones often hold more phytoliths than handstones and that the number of phytoliths seems to increase with the intensity of the usage of the tool. Thus, the grinding tools were used for processing different kinds of grasses, and maybe even of early cultivars, while polishers were used for other activities such as processing hides or polishing pottery.

Ground stone fragments occur at the same sites as the grinding stones and are produced from the same types of raw material. These tool fragments illustrate the high fragmentation rate of the grinding tools which can reach as much as 5 times the fracture rate of some of the other tool types. This particular treatment of grinding stones, i.e. their deliberate fragmentation, may indicate their special meaning. Besides all sorts of functional explanations, deliberate destruction as some form of ritual destruction must be considered as well.

By showing an arrangement of two or three functionally different aspects, the combination tools are highly utilitarian and compact. Their characteristic features correspond to the features of the 'single activity' tools as the same basic shapes and working areas occur. This also applies to the conducted activities and the choice of raw material. For all types of combination tools the dominance of different types of sandstones and quartzites (72 %) is observed, always in combination with granites or gneisses (24 %). Four weight classes are presented, c. 50 g to 400 g, c. 500 g to 900 g, c. 1200 g to 1500 g, and the last class weighs approximately 4400 g.

A wide range of different polished axe types is present at the Swifterbant type site. These range from shaft-hole axes to axes with hourglass perforations and axes with oval cross section. The shaft-hole axe found at the site, characterised by a straight or lightly conical perforation, is an imported product from the farming communities in the southeast (Rössen or one of its descendants). The axes with an hourglass perforation are all made out of a northern raw material type and are defined as local products or copies of these imported shaft-hole axes (figure 6.1). Even though they have a tilted cutting edge, use-wear analysis confirmed that the axes were used. The axes with oval cross section, thus without perforation, have a Neolithic date and are often related to the Rössen and Michelsberg culture, they were even still in circulation during the TRB (Brandt 1967, Schut 1991, Bakker 1979, Hoof 1970). The raw material types of the specimens at Swifterbant suggest a southern origin; although a northern origin of one of them cannot be ruled out.

Even though shaft-hole axes are very often used to cut down trees, it could not be corroborated that the axes at Swifterbant had been used in such a way. As one of the axes with oval cross section has impact traces on its butt, it may have been used as some sort of wedge, also possibly during wood working.

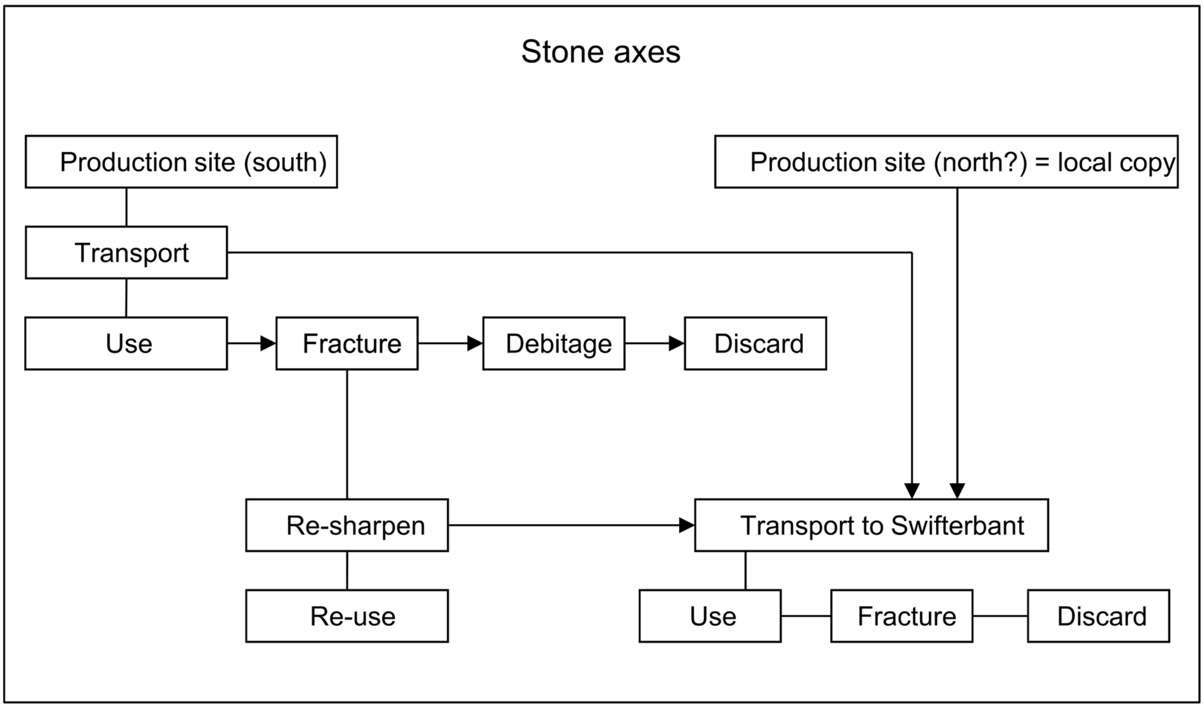

Figure 6.1 The production sequence of stone axes at Swifterbant.

The ornaments, defined as (unfinished) pendants and beads, or fragments thereof, were mainly made out of amber (69%) or different types of sandstones and quartzites (27%). Rare specimens are made of shale, radiolarian rock, or jet (4%). The amber ornaments are of northern origin, whereas the stone artefacts are most, if not all, of southern origin.

The lack of any kind of modelling is also to be observed for the ornaments. Apart from making an hourglass shaped perforation, none of the artefacts appears to be cut into shape or altered in any way. It was observed that the perforations of the amber ornaments are set more closely to the edge as those of the stone pendants, possibly as a result of the limited size of the objects. Additionally, the inner diameters of the amber ornaments' perforations are larger than those of the stone pendants. This might be related to the softness of the material, the duration of use or wear, or a somewhat different perforation technique. As the amber ornaments were most likely not produced at the site, whereas the stone ornaments were, a difference in technique or perforation device is possible. Even though the flint borers found at the site can no longer be used to perforate ornaments due to their blunted tips, the striations in the perforations of the stone and flint pendants prove the use of such a device.

The relationship between ornaments and cemeteries has been established as part of the ornaments was retrieved from burial contexts. The ornaments presumably were the personal belongings of the people who wore them and were buried with them. Personal ornaments may reflect social identity, social status or wealth, or maybe even ethnic identity. Both women, men and children were buried with them, pointing to the presence and importance of personal belongings from childhood onwards.

On the sites of Hazendonk and Brandwijk the information on stone artefacts is very limited or even totally absent. At Hazendonk only flat pebble ornaments are recorded. It also appears that grinding stones were absent during the Swifterbant occupation phases. It is only in the subsequent Hazendonk 3 phase (3700 – 3600 cal BC) that fragments of polished flint axes, grinding stone fragments, and an anvil are attested.

An overview of the stone industry during the late Swifterbant phase is somewhat hampered by the lesser quality of the sites Urk and Emmeloord. At Urk the stone artefacts were not analysed in detail, as most attention was given to the amber ornaments found in one of the graves. The two pendants and five beads were presumably strung around the man's head, just as seen at Swifterbant. The beads and pendants were still formed out of natural lumps of amber and an hourglass perforation is the only alteration to be observed. Both the amber ornaments and the other stone artefacts have been subject to heavy weathering. Therefore it cannot be ruled out that some of this material may have been temper ready to be used for pottery production. Other artefact types in common with the Swifterbant type site are two quartzite flakes and a few hammerstones, yet their origin could not be traced back to the Swifterbant occupation layer with absolute certainty.

The long occupation history at Emmeloord also obscures a clear picture of the tool types used during the Swifterbant phase. It was observed that the stone assemblage was exclusively made of a wide variety of stone types collected from the boulder clay deposits. As the territory of the Swifterbant culture in the late phase was shrunk to the river systems of the IJssel/Vecht/Eem, the limited amount or even absence of southern stone types from the Utrechtse Heuvelrug or the Veluwe is to be expected. Tools at Emmeloord are scarce and it appears that at least hammerstones were used during the Swifterbant phase, and possibly also some axes. The preference of cobbles of different types of sandstones and quartzites for the production of hammerstones still seems to be upheld. As some of the hammerstones also show traces of smoothing or even polish, they may be defined as combination tools, as seen at Swifterbant. The grinding stones (saddle querns) and whetstones possibly all belong to the later occupation phases.

Synthesis

Throughout the 1600 years of Swifterbant culture the stone industry keeps loyal to its Mesolithic ancestry while new, Neolithic aspects were introduced. Cobbles of certain raw materials were selected dependent on the function they were selected for. This correlation between function and raw material type may be observed throughout the whole Swifterbant history. The same applies to the selection of cobbles that comfortably lie in the hand and could be used without any alteration. Procurement sites seem to be consistent throughout the whole culture as well, primarily being the boulder clay outcrops and the Meuse deposits in the middle of the Netherlands.

The only site, other than Swifterbant, where a certain amount of stone artefacts have been found in Swifterbant occupation layers is De Bruin. Yet, in comparison to Swifterbant, they form only a small portion of the inorganic archaeological remains, i.e. 9% - 12% versus 33%.

Debitage material is rare at most Swifterbant sites. During the Early Swifterbant phase they have only been observed at Hoge Vaart. During the other Swifterbant phases their presence was only attested at Urk (2 flakes). The number of flakes and blades at the Swifterbant type site, a total of 492 and 15 respectively, is thus very unusual. At other sites, for example sites Ypenburg (3860 – 3435 cal BC) and Schipluiden (3630 – 3380 cal BC), attributed to the Hazendonk Group (Koot et al. 2008: 443, Louwe Kooijmans 2006: 506), up to 10 and 121 flakes respectively have been found (Houkes 2008b: 248, van Gijn & Houkes 2006: 169). Possibly the large number of flakes is related to the domestic character of the site or at least related to a specific activity. As Ypenburg, Schipluiden and Swifterbant site S3 are interpreted as base camps, this would be a possibility. However, the presence of similar (c. 30%) or even larger amounts of flakes are also seen at other levee sites at Swifterbant of which some are interpreted as special activity sites. The conclusions of van Gijn and Houkes (2006) are in line with the results in this research. For example, it is their opinion that spent grinding stones were intentionally reduced to flakes, an idea similar to the theory presented here. Even more, use-wear analysis at Schipluiden revealed that flakes were used for woodworking (van Gijn & Houkes 2006: 183).

Within the toolkit, it is especially with the *hammerstones* that the Mesolithic ancestry of the Swifterbant culture is clearly visible. Hammerstones are attested from the earliest Swifterbant sites onward, and even then the preference was for them to be made of different types of sandstone and quartzite. At all the sites discussed in this research, this preference may be observed, including Swifterbant. Even the use of different weight classes, i.e. hammerstones versus *retouchoirs*, is attested throughout the Swifterbant history.

Anvils are a second type of tool which are present from the earliest stages onwards, yet in lower numbers than the hammerstones. Their function, and especially the contact material, is very diverse ranging from crushing red ochre, processing food and plant material, producing temper or for flint knapping. They do not occur at all on some of the discussed sites, i.e. Hoge Vaart or Emmeloord. However, their general low number on Swifterbant sites other than the Swifterbant type site is possibly of relevance here.

Even though cereal cultivation did not occur until the Middle Swifterbant phase, *grinding stones* are observed from the earliest stages onwards. At that time, contact materials must have been wild food resources or even colourants, yet as their number is low this is hard to determine with certainty. At Swifterbant traces of processing cereal grains or other siliceous plant material was established. Other functions were presumably present, for example polishers used for hide processing or even smoothing pottery, yet could not positively be identified. An interesting interpretation in this respect is a whetstone found at Emmeloord. Kars suggested the tool was used for polishing bone awls and needles (Kars 2002: 102).

It appears the term "combination tools" was only used in this research. Combination tools do occur at other Swifterbant sites, yet are not as clearly defined as in this research.

It appears *polished stone axes*, and fragments thereof, have only been encountered from the Middle Swifterbant phase onwards. Perforated and/or non-perforated specimens occur at all levee sites at Swifterbant, and in combination with their absence on river dunes S61 and S80-S84, it appears they may have been introduced at around 4300 cal BC. The only other sites where axes have been found are Bergschenhoek[48] and Emmeloord.

Yet, the axes at Swifterbant are of a unique kind. Some are local copies of shaft-hole axes, characterised by a tilted cutting edge. The Swifterbant type site is also special because of the presence of an imported shaft-hole axe found in situ at site S3 which is a rarity in the Netherlands. Another exceptional aspect of these axes is that they suggest contemporaneity of occupation within the short occupation span of the different levee sites. The retrieval of different fragments of the same axe from different sites indicates (a certain amount) of contemporaneity, especially since the levee sites were flooded regularly and would cover any material lying about.

One type of tool not recovered at the Swifterbant levee sites is an *arrow shaft polisher*. Such tools are generally encountered at Mesolithic sites (Peeters 2001b: 12). In this respect, it is no surprise some were found at De Bruin and Hoge Vaart, both sites with Mesolithic occupation phases. The same accounts for Swifterbant trenches S21-S24, and more specifically trench S25, were recent research revealed one possible specimen (Raemaekers et al. 2011a). Very similar objects are grinding stones used to polish bone awls. They too have a straight, narrow gouge in the middle of the surface. For example, one was found at Schipluiden (van Gijn & Houkes 2006: 178-179). In order to determine the function and contact material of the gouged tool found at Swifterbant trench S25, use-wear analysis should be conducted.

Another Mesolithic stone tool sometimes found on Neolithic sites is a mace-head or *Geröllkeule*. A fine specimen was found at the bottom of a hearth pit in trench S22. It is an exceptional archaeological find as it is the first specimen securely dated to the Mesolithic in the Netherlands (see Drenth & Niekus 2008, 2010). Also at Hazendonk, a fragment of such a tool was found (Louwe Kooijmans 2005: 266).

Ornaments may also be seen as a Mesolithic inheritance. In the absence of Mesolithic or Early Swifterbant finds, the amber beads and pendants recovered at the Swifterbant site itself are the oldest in the Netherlands. Only at Urk, have other amber ornaments been found. At these two sites, the relationship between ornaments and cemeteries has been attested. Even more, the way in which the Swifterbant people were buried, lying outstretched on their back in little cemeteries, also appears to be a Mesolithic inheritance (Smits & Louwe Kooijmans 2001: 432). The ornaments presumably were the personal belongings of the people who wore them, and because women, men and children were buried with them, the presence and importance of these personal belongings was established from childhood onwards. It was also argued that these personal ornaments may reflect social identity, social status or wealth, or maybe even ethnic identity. At the Hazendonk sites Schipluiden and Ypenburg the use of jet as raw material is much more frequent than at Swifterbant, and even outnumbers the amber ornaments. The southern location of both sites, closer to the source of jet, is believed to be of significance here. These findings are in line with the research results of van Gijn (2006, 2008b).

Somewhat in contrast to this ornament-cemetery relation is the fact that most of the ornaments at Swifterbant have been retrieved from the cultural layer of site S3. The production, discard, and loss of ornaments during the occupation of a certain area is to be expected, as it was also seen at Schipluiden. However, the magnitude of the occurrence at site S3, as compared to the other sites of the Swifterbant cluster, seems rather remarkable at first. It would suggest that the occupation at site S3 is of a longer duration or larger magnitude than was at first imagined. However, as site S3 is interpreted as the main settlement site this is to be expected.

The only other Swifterbant site where stone pendants are mentioned is Hazendonk. Just as at Swifterbant, flat pebbles were used. Whether unfinished pendants were recovered is unclear. At Schipluiden one unfinished pendant was recovered (van Gijn 2006: 202).

The final type of pendants are those made out of animal teeth. At Swifterbant, teeth of cattle, wild boar, pig, horse, otter, and dog were used. The recovered beaver teeth did not show any macroscopic traces or alterations and are presumed not to have been used or worn. The only other Swifterbant site where an animal tooth pendant (beaver) was described is Emmeloord. Perhaps more remarkable is the absence of animal teeth pendants at Schipluiden and Ypenburg, or any other site of the Hazendonk Group. However, at Vlaardingen and Hekelingen I two specimens were recovered (van Gijn 2006: 203, Modderman 1953).

The difference between waste and artefacts < 3 gram or grit is not always made in other research. They are both set aside from tools and flakes, thus often seen as one whole, i.e. pieces of stone without any traces of use or alteration. With or without the division, waste and grit must have been part of the stone assemblages at all the Swifterbant sites, even if they are not mentioned or analysed.

At De Bruin they are encountered in large numbers, whereas at Polderweg only one occurred (Swifterbant phases). It was observed that the pieces at De Bruin are generally smaller than those found at Polderweg (all phases), presumably due to usage, and mostly weigh less than 20 g (86%) (van Gijn & Houkes 2001: 195, 199). These percentages are very like those at Swifterbant,

48 Louwe Kooijmans (1987: 240) only mentions a polished stone axe fragment for this site.

where 85% weighs less than 20 g, 9% weighs up to 100 g and 6% even up to 4400 g. At Hoge Vaart the presence of crushed white quartz and red granite (grit) is interpreted as pottery temper ready to be used. A function as cooking stone is also postulated for the large fragments of quartz; an interpretation also seen at De Bruin.

The Late Swifterbant sites are also characterised by waste, at Emmeloord this percentage is even as high as 99% of the stone artefacts. Here also the fragmentation rate is described as high and is related to both usage and heat exposure.

The connection between usage and fragmentation on the one hand, and heat exposure and fragmentation on the other is given at several of the above mentioned sites, yet rarely expressed in exact percentages. The exceptions are De Bruin and Polderweg. At De Bruin heat exposure is assessed between c. 65% and 70% for phases 2 and 3 whereas this is c. 18% for phase 1 (van Gijn & Houkes 2001: 201). At Polderweg this is 22% for all the phases together (van Gijn et al. 2001c: 172). General interpretations are the use as cooking stones or hearth stones. At Swifterbant heat exposure is established for 4% to 9% of the artefacts. This is considerably lower than at both other sites. It is unclear whether this is related to the use of stone hearths versus clay hearths (site S3) or a difference between practices or activities during the Early phase as compared to the Middle Swifterbant phase. It was suggested that cooking stones were no longer needed when pottery was introduced (van Gijn & Houkes 2001: 207). Further research into the matter is clearly needed.

6.3.9 Flint industry

In the river basins of the Rhine/Meuse and the Scheldt continuous occupation from the Late and Final Mesolithic into the Early and Middle Neolithic has been attested. Within the flint industry of the early phase of the Swifterbant culture this Mesolithic inheritance is clearly visible.

At Polderweg flint procurement occurred from secondary deposits in the Meuse valley, or from the Meuse deposits in the middle of the Netherlands, implying a rather local to regional raw material collection at outcrops located within the year territory. The gathering of especially small nodules of Meuse eggs, and to a lesser extent of Rijckholt flint and terrace flint, is observed. Northern flint and Wommersom quartzite are attested in the Mesolithic occupation layers, yet their absence in the Swifterbant occupation layer at Polderweg does not need to be of any significance as they both occur at the twin site De Bruin.

The flint debitage is clearly characterised by flake production, whereas blades occur far less. As cortex is present on half of the artefacts, including the cores, the small dimensions of the selected nodules are most likely responsible for the dominant use of the flake technique. The rather high number of rejuvenation pieces and cores, in combination with the presence of chips, suggest the production of all these blanks at the site. Yet, the flint assemblage is characterised by mainly larger artefacts which outnumber the chips at the site. This may, however, be the result of setting the limit between both groups at 5 mm[49], also impeding comparison to other sites. The debitage material forms the principal artefact group within the set of larger artefacts, followed by the waste material while the percentage of tools is rather low, which is similar to Swifterbant sites S3 and S4. The toolkit focuses on retouched flakes whereas other tools occur rarely. It must be mentioned that the overall number of flint artefacts, and more specifically of the tools, is very low possibly affecting this overall image and toolkit composition. This also applies to the representativeness of the use-wear analysis that often showed traces of plant processing, whereas bone and antler processing occurred less, and hide working appeared only once. Evidence of hafting was also found, as seen at the levee sites S3 and S4 at Swifterbant.

The flint assemblage at De Bruin is also characterised by flake production. The blades occur less often, yet somewhat more than at Polderweg[50]. Again roughly half of the artefacts are still covered with cortex implying small sized nodules. With the dominance of Meuse eggs attested once more, as is the addition of terrace flint and Rijckholt flint, the same procurement sites may have been visited. Yet at De Bruin the presence of northern flint and Wommersom quartzite is attested, even if the amount of Wommersom quartzite is very low. The chance the latter would be present in the small sample of the contemporary site Polderweg is very slim, that of northern flint is somewhat more. The absence of Wommersom quartzite at Polderweg is, therefore, not seen as significant, just presumed to be the result of the limited amount of artefacts. Yet, this suggests the procurement distance is farther than anticipated. The Utrechtse Heuvelrug may be the most likely source for the northern flint, as it is the nearest source, whereas Wommersom quartzite only occurs in Belgium near Tienen, which are distances of approximately 40 km and 110 km respectively. This does not necessarily mean that Tienen was part of the year territory; it only implies the sphere of influence reached that far.

The flint assemblage at De Bruin is characterised by a larger amount of chips than at Polderweg. The low percentages of cores and rejuvenation pieces are consequently inconsistent with the assumed production of blanks at the

49 At De Bruin the boundary between chips and larger artefacts is set at 5 mm; for the stone artefacts this is 5 g. By absence of any other evidence, it is presumed the same technique is applied to the material at Polderweg.

50 The blade-flake ratio at De Bruin is 1:2.7, instead of 1:3.4 at Polderweg.

site as indicated by this large amount of chips. It is therefore a possibility that some material was transported from De Bruin to Polderweg, raising the number of larger artefacts at Polderweg.

Within the set of larger artefacts, the debitage material forms the main group, followed by the waste material and the tools. Although the flint toolkit is much more abundant and diverse than at Polderweg, the dominance of retouched flakes is still attested, along with a high number of retouched blades, all similar to Swifterbant sites S3 and S4. Scrapers occur in larger amounts, whereas arrowheads are plentiful (microliths, trapezes and transverse arrowheads). Some tool types may be observed that are not present at Polderweg, such as borers, burins, and combination tools. This also holds for the splintered pieces, which are different from the bipolar pieces at the Swifterbant levee sites. Yet, these different tools did not reveal other types of activities, only different proportions. Use-wear analysis indicated mainly traces of hide working while plant processing was encountered far less. Bone, antler and wood processing occurred occasionally. Only the limited evidence of hafting is similar to the proportions at Polderweg.

At Hoge Vaart, located in the river systems of the IJssel/Vecht/Eem, a clear preference for northern flint, both with and without bryozoans, was attested. Southern flint types only represent 3% of the material. Also a single bladelet of Wommersom quartzite was found. The collection of these flint types occurred from secondary, local and regional contexts. Near the site these are the eroded periglacial sand deposits, i.e. the Utrechtse Heuvelrug (8 km) for the southern material and the Veluwe (20 km) for the northern material, thus not the boulder clay deposits. Farther away these are possibly the beaches (c. 50 km). The Wommersom quartzite bladelet must have been imported from Belgium or should be regarded as being picked up from another site. Whether it belongs to the Mesolithic or Swifterbant occupation phase is thus open to debate.

Even though technical analysis indicated that blade production was the primary goal, slightly more flakes than blades are present in the analysed sample, just as more flake cores than blade cores are present. The presence of cores and rejuvenation pieces, combined with chips, point to the local production of blanks, at least to some extent. In general the number of cores and rejuvenation pieces is rather low. Even more, it was observed that some larger blade fragments and flakes were not produced at the site but brought in from elsewhere.

For the production of tools, blades are used twice as often as flakes. Other types of blanks such as cores or rejuvenation pieces are exceptions. Arrowheads are almost exclusively made from blades, scrapers mainly from flakes. The toolkit mainly consists of blades with visible use-wear traces, while trapezes, retouched blades, and scrapers occur regularly. Retouched flakes occur even less while the other tool types are represented by only a few. The raw material used for these tools shows the same dominance of northern flint as for the whole assemblage. Only for the arrowheads was a clear selection of blades of high quality flint observed. For the scraping and cutting tools this selection was neglected. The dominance of projectile points is to be expected in hunting camps. Yet, the large number of retouched and used blades, combined with scrapers, do not only suggest butchery and primary hide processing (fresh hide), but also some final stages of hide processing (dry hide). Some periods of extended stays are thus suggested.

At Doel the information is not that abundantly present, yet some of the material was studied in detail providing a fair insight. The preference for flint gathered from a local and secondary procurement site is clearly demonstrated. The presence of low numbers of quartzite, often finished products or usable blanks, is also observed. These are Wommersom quartzite and quartzite from Tienen, both gathered at c. 80 km from the site.

Even though the lithic assemblage is focussed on the production of flakes, characteristic aspects are regular (Montbani) blades, trapezes, different types of microliths, and artefacts made out of Wommersom quartzite such as small scrapers. The presence of different types of microliths and of artefacts made of Wommersom quartzite is a clear survival of Late Mesolithic traditions. However, the Swifterbant trapezes are smaller than their Late Mesolithic counterparts and also of a different morphology. Additionally, as Doel is located closer to Tienen than Polderweg and De Bruin, and especially Hoge Vaart, a larger number of artefacts made out of Wommersom quartzite is to be expected.

As said, the flint production is characterised by the dominance of flakes and the number of blades is quite low. The very small number of rejuvenation pieces and cores is rather exceptional, certainly in combination with the large amount of chips; the latter clearly dominate the assemblage at the site. The cores are small in dimension, also visible in the limited size of the flakes, and depict mostly flake scars. The few larger and regular blades, just as the Wommersom blades, are most likely not produced at the site. The toolkit is dominated by scrapers, followed by retouched blades and flakes. All other types of tools, like borers, burins, rounded and splintered pieces but also arrowheads, are represented by a few specimens. For the tools the largest flakes and blades are chosen as blanks. The selection of certain blanks for certain tool types may be observed, scrapers are mainly produced out of flakes, and blades are chosen to be used unaltered, also observed at Swifterbant, or to be altered into retouched blades or Montbani blades.

The wide typological variety of the debitage material and the tools suggests a rather broad-spectrum site with hunting, fishing, and gathering. Evidence of domesticated food remains is limited to a single cereal grain. Combined with use-wear analysis that confirms the processing of dry hides, wood working, and plant processing, this suggests a settlement site or at least a broad-spectrum camp with extended stays.

During the younger occupation phase of De Bruin (4700 – 4450 cal BC) the flint material is less abundant. Yet, the dominance of the larger artefacts over the chips is still attested validating the argument that this result is based on the type of analysis. Coastal flint and northern flint are more equally represented now, the other types of flint occur in the same small amount. Similar provenance areas may thus be expected. The larger share of northern flint might already indicate the stronger influence or connection to the northern areas in the Swifterbant culture.

The debitage material is still predominantly present, followed by the waste material and the tools, yet the latter show a slight elevation in number compared to the earlier phases. This may be linked to the fact that Polderweg was no longer inhabitable and all activities were thus restricted to De Bruin. The production still focussed on flakes although blades became rather frequent. Cores and rejuvenation pieces were present in equal numbers, just as the amount of cortex implying the use of the same small nodules. The toolkit, however, shows the first signs of clear changes. From 4700 cal BC onwards, the percentages of the projectile points roughly remained the same, it is their typological combination that clearly differs. The total absence of different type of microliths, i.e. the exclusive usage of trapezes and transverse arrowheads, may be observed. A greater importance of retouched flakes, blades and scrapers was attested as well. Maybe this is not so much a greater importance of these tools than it is a loss of the other tools, and maybe even of the matching activities. Use-wear analysis revealed similar traces as compared to the previous phase with the exception of wood working. Additional traces of contact with mineral substances were detected, an aspect seen at the levee sites at Swifterbant, but also at Hoge Vaart, implying a different function of the site, or at least shifting activities.

The middle Swifterbant phase has been elaborately studied in this thesis by means of the Swifterbant type site. The analysis revealed a difference between the flint material from the levee sites and that of the river dune sites. The latter were mainly occupied during the Mesolithic, whereas the levee sites were only inhabited for a few hundred years during the middle Swifterbant phase. Therefore, the characteristics of the flint material of the levee sites will be discussed here, characteristics that have been observed at the river dune sites as well, yet to a much lesser extent.

The flint assemblage is nearly exclusively of northern flint with or without bryozoans. The primary source for these flint types is the boulder clay deposits with the outcrops of Urk and Schokland (10 and 14 km) as the most likely source. Even though some flint artefacts show affinities to southern flint types, there has been no positive identification of southern material as such, possibly with the exception of the polished flint axe fragments.

Two different flint production techniques are attested. The first is used at the settlement site, presumably by all the inhabitants, and is aimed at the production of everyday tools and needs. This debitage technique focused on the production of flakes from small nodules by using little or no core preparation. The production planes were rather maintained by reorienting the core a quarter or half a turn. Flake debitage dominated the initial stages of reduction, while the production of small blades was carried out once a guiding ridge was created. Small blades were produced with only a little more care and preparation. The flakes and blades are predominantly detached in a unidirectional way. Yet, nodules have been used to produce bipolar pieces as well. The bipolar technique was applied on the smallest nodules as it ensures the success rate of usable flakes per 'core' as it is a better adapted debitage technique for small nodules.

The second technique focuses on the production of large, regular blades which were produced 'off-site' by specialised or certain, skilled people. It appears the flint types do not appear to be different from the other material used at the site, only that the material is bigger, suggesting similar procurement sites, yet the selection of specific, large nodules. The blades are long, up to 50-60 mm, have parallel edges and mostly two ridges. Possibly, they were produced with indirect percussion or even pressure technique, implying the need of better knapping skills than the material produced at the site. Their large number, more than 1000 pieces, suggest a steady production and supply system.

At all levee sites, the debitage material represents the largest amount of artefacts ≥ 1 cm per site, followed by the waste material and the tools. The four other artefact categories, bipolar pieces, artefacts with visible use-wear traces, polished flint axe fragments, and ornaments, occur rarely and not even on each levee.

The tools are mainly made on flakes. Yet, for certain tool types blades were the preferred type of blank, for example for trapezes, borers and artefacts with visible use-wear traces.

The scrapers are the most common flint tool found on the different levee sites. They are mainly made on flakes which creates a rather large morphological variation. The scrapers on blades have a more regular appearance. Yet, in technical terms most scrapers are alike. The dominance of end scrapers, more often single than double, over side and round scrapers is clearly observed. Scraper fronts are generally located distally and dorsally. Some larger end scrapers have gloss on one or two of the edges of the blade. This indicates a prior, a secondary, or an alternate use.

Scrapers may be used for a wide variety of activities of which the processing of hide and plant material are the most common. Small specimens may also be used for the scraping or smoothing of fresh pottery, whereas bone or wood may also be worked with scrapers even though this is not their most common use.

Borers are not that common and could not be found on each levee site. Although they are predominantly made from blades, their technological variation is rather large. The retouched edges are formed by dorsal or ventral retouches, or a combination of both, whereas the tip may be located either proximally or distally. Rounding-off of the borer tip has been observed in a few occasions on nearly all sites.

Their function is rather straight forward, yet the contact material may be varied. The perforation of organic materials such as hide, bone or possibly even plant material such as wood may be suspected, as well as inorganic materials such as stone or pottery.

The rounded pieces are mainly produced from blades, yet the variety of other blanks is rather large. They are more often characterised by one rounded end than by two. The location of the rounding seems to be related to the overall shape of the blanks which can be triangular in cross section or have a more flat appearance. This dichotomy in shape presumably led to the selection for a different activity resulting in dissimilar rounding patterns. The rounded pieces seem to be used both in perforating motions as in scraping motions. As several other tools show rounding at their tips like scrapers, borers, and retouched pieces, this indicates the variety of activities that leads to rounding.

Use-wear analysis revealed that the rounded pieces indeed had multiple functions. Traces on the edges of some tools point to simultaneous performed activities as well as sequential performed activities, i.e. the re-use of the tools. Activities performed with these tools may range from making fire, over processing and perforating all kinds of material including hide, siliceous plants, bone, antler, wood, or even stone and pottery, to the pulverisation of soft, mineral substances. That the rounding-off is the result of some kind of hafting arrangement is also an option.

Trapezes are the main arrowhead type at the levee sites from Swifterbant. A preference for fine-grained flint without bryozoans is observed, just as is the use of blades as blanks. The asymmetrical trapezes are the most common type. The use of trapezes as arrowheads is likely, yet the sharp edge of the tools may also have been used to cut or scrape plant material or other substances.

The transverse arrowhead, rarely occurring at the sites, is mainly distinguished from the trapezes by their longer width than length; on other aspects they only slightly different. They are produced somewhat less systematically and their morphological variation is larger, yet technologically they are very similar.

The retouched pieces are always the largest group of tools. They consist of retouched flakes, retouched blades, and other blanks with retouches.

The retouched flakes generally have short, abrupt or semi-abrupt retouches that follow the natural curvatures of the blank. These are often convex, rectilinear or concave, yet an existing fracture may be used as well. Denticulated or notched edges occur only now and again. The retouches are mostly produced on the dorsal face and often distally.

The retouched blades are predominantly backed blades and far less denticulated, notched or truncated blades. For the larger part regular blades were used with two parallel edges and ridges. The retouches are located on one or two edges, mostly on the dorsal face, less often on the ventral face, and sometimes even alternate. The intact blades can measure up to c. 60 mm, which is larger than the unretouched blades, suggesting the selection of the larger specimens for tool production.

The remaining retouched pieces were made on a variety of blanks, such as striking edge rejuvenation pieces, indeterminate fragments, frost flakes, nodules, cores, and bipolar pieces. All these tools have short and undeveloped retouches that do not alter the general shape of the edges. In contrast to the retouched flakes and blades these occur both dorsally and/or ventrally.

As with the scrapers, retouched tools may have been used for a wide variety of activities. Cutting, pealing, or scraping of plant material are some of the many possible tasks performed. The processing of meat, hide, wood, bone, and antler are all very likely as well.

A small number of indeterminate tools occur as well. Their shapes and dimensions are very diverse ranging from battered cores or possible hammerstones to pointed tools or projectile points. At every site, the toolkit also consists of different sizes of indeterminate tool fragments.

The bipolar pieces are separated into three groups of which the irregular type appears the most. Regular bipolar pieces occur far less while square shaped pieces are the rarest. Although their morphology differs their dimensional ranges are very alike. They have a lenticular cross section created by the two opposing striking ridges. Sometimes reorientation by a quarter turn was observed, to apply a second debitage axis in an attempt to detach more flakes.

Use-wear analysis suggests that few of the numerous bipolar pieces were used. The opportunistic use of a few of them was however demonstrated. Yet, these traces do not correspond to the presumed function bipolar pieces have, i.e. wedge or core. It can, however, not be ruled out that the bipolar pieces were used as wedges or cores but that

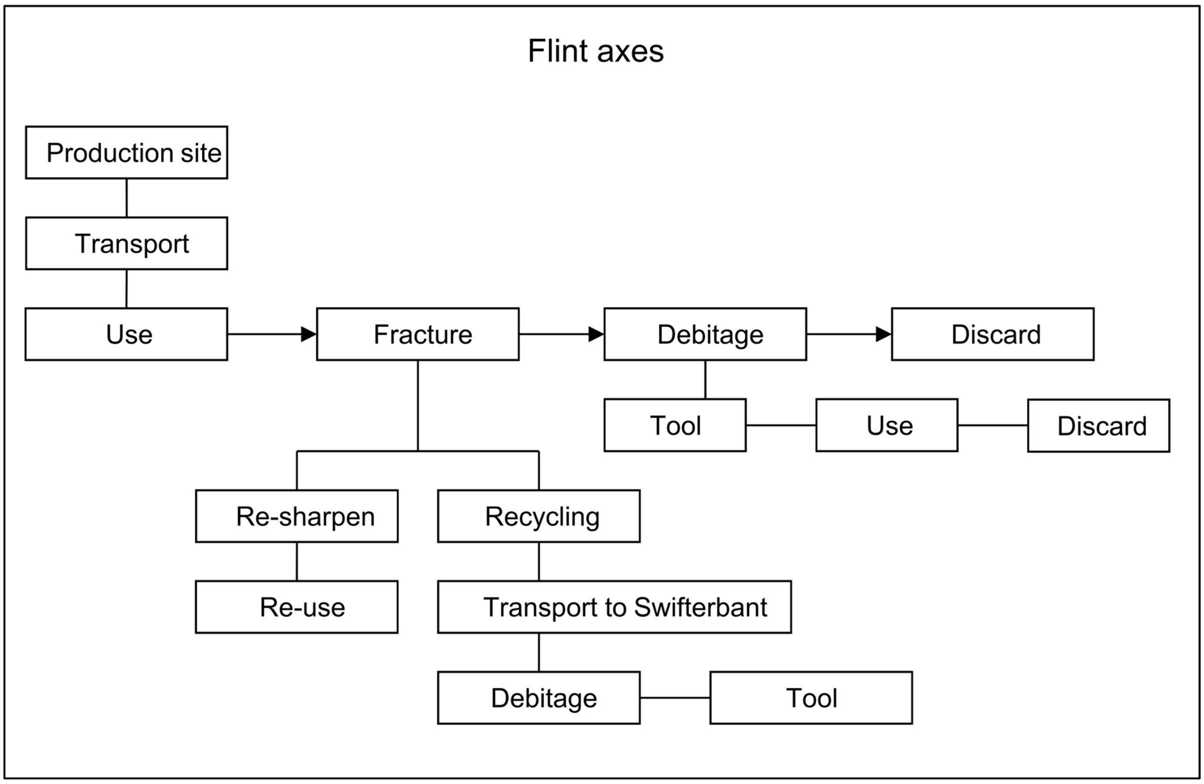

Figure 6.2 The production sequence of flint axes at Swifterbant.

in that case these activities did not leave any traces on the pieces themselves.

For the artefacts with visible use-wear traces blades were clearly preferred over flakes and other blanks. These blades are selected on the basis of their exceeding length and are nearly all of the regular type with parallel edges and ridges.

Use-wear analysis revealed that the blades were frequently used to process siliceous plant material, mostly in a scraping motion, cutting was observed far less. Traces of processing hide and antler were also discerned, yet only in small amounts. Evidence also revealed that some of the artefacts must have been hafted.

No fully intact polished flint axes, or even larger parts, have been found. Nearly all artefacts are flakes or smaller pieces of debitage. It is therefore impossible to determine the original shape or type of any of the axes. None of the flint types could either positively be identified as southern or otherwise. It is presumed they were 'imported' as fragments (figure 6.2). Therefore, the idea that axes were brought to the site as a supply of raw material (Deckers 1982) is refuted.

Two more special artefacts have been found. These comprise an unfinished pendant and a hammerstone.
The unfinished pendant is quite remarkable as its raw material sets it aside from all other unfinished pendants found at Swifterbant. The same accounts for the hammerstone, although one core was found which was re-used as a hammerstone.

The information on the lithic artefacts at Brandwijk is rather limited; nonetheless, some general characteristics may be clear. The gathering of flint nodules occurred locally or regionally from secondary procurement sites and focussed on small sized nodules of coastal and terrace flint.

The debitage technique is clearly aimed at the production of flakes as these occur far more often than blades. The dimensions of these flakes and blades are generally limited as the result of the small size of the nodules. However, this material forms only one aspect of the two different debitage styles observed at the site. The other aspect is a set of large blades and neatly retouched, large tools produced out of Rijckholt flint. As this second set of artefacts clearly show Michelsberg affinities they were most likely brought to the site as finished products while the smaller flakes and blades were produced at the site itself from the small nodules. Even though Brandwijk is the only Swifterbant site where Michelsberg affinities have been observed so far, the presence of large, regular blades which are not produced on site have also been observed at Hoge Vaart, Doel and Swifterbant.

The toolkit at Brandwijk consists of retouched flakes, scrapers, and retouched blades. During the different occupation phases, the typological composition of the arrowheads seems to evolve from trapezes in an early, preceding phase (layer 30 / 4500 cal BC) to leaf- and drop-shaped points in the Swifterbant phases (4200 – 3800 cal BC). The latter two arrowhead types appear to have been characteristic for the Rhine/Meuse basin during the middle Swifterbant phase, whereas trapezes were still the norm in the Swifterbant area farther north. This change from trapezes to leaf- and drop-shaped points most likely happened under the influence of the Michelsberg culture in the Rhine/Meuse basin. Other developments may be observed as well. The absence of polished flint axe fragments and a different kind of pottery sets aside the early, preceding phase from the Swifterbant layers. Still, as the flint artefacts in this preceding phase are of a rather low number this conclusion is made with some reserve. The augmentation in artefacts without cortex or patina in the successive Swifterbant layers is most likely related to the increasing amount of imported artefacts of Rijckholt flint, Light-grey Belgian flint, and polished axe fragments. These not only indicate contacts with the south and the Michelsberg culture, but also imply the intensification of these contacts during the successive occupation phases of the site.

The information on the lithic artefacts at the Hazendonk site is possibly even more restricted as the excavations produced little flint and presumably even less stone artefacts. The representativeness of the material may therefore be questioned, especially as the results are different from the other sites in the Rhine/Meuse basin. The publications indicate that the flint assemblage is based on blade technology, presumably of the regular kind as the Hazendonk blades were compared to those from Swifterbant (Louwe Kooijmans 1976: 257, 2005: 266). As the flint material is low in number and so briefly analysed, it cannot be confirmed whether the blades are only predominantly present in number or whether the flint industry is aimed at the production of regular blades, with many flakes at the site as observed at Hoge Vaart. Whether the regular blades are produced on site, or elsewhere, is a different question altogether. Only a detailed analysis of the Hazendonk material may provide an answer as to why Hazendonk is the only Swifterbant site in the Rhine/Meuse river basin, or even the Alblasserwaard, to focus on regular blade production, or where large, regular blades occur at all. The presence of a triangular arrowhead of southern flint might indicate a southern influence as seen at Brandwijk, providing some explanation.

During the late Swifterbant phase territory shrunk to the IJssel/Vecht/Eem river basins. At Urk the flint assemblage was mainly made of northern flint. This is most likely gathered locally from the boulder clay deposits and thus of lesser quality. As at Emmeloord, the admixture of southern flint is very limited.

The debitage is clearly aimed at the production of flakes, which are present in very large numbers. Most of them were detached using direct hard percussion. Yet, the bipolar technique was in some cases observed as well, just as a few bipolar pieces. The limited number of rejuvenation pieces and the many cores suggest nearly exclusive flake production at the site. A limited number of blades was systematically produced using indirect percussion and these are of the regular type. They are also made of a better quality of flint. Most of the blades are broken, yet some of them are longer than 50 mm. In combination with mainly flake cores this suggests that the large, regular blades were not produced at the site, a recurring characteristic. Nonetheless, a small set of blade cores, of better quality northern flint, was retrieved. It is possible these belong to the Mesolithic occupation phase at the site, implying the exclusive use of flake debitage at the site and the 'imported character' of all the blades during the late Swifterbant phase.

The toolkit is dominated by scrapers and retouched blades, which are typo-morphologically very similar to the material from Swifterbant. The gloss on some of these retouched blades indicates their use for processing soft plant material, also implying similar activities to the Swifterbant levee sites. The remaining tool types such as borers, rounded pieces, arrowheads, and retouched flakes appear far less. A large set of indeterminate tools are present as well. The selection of raw material type and type of blank is related to the type of tool. For arrowheads, scrapers, and retouched pieces preference was given to northern flint without bryozoans, the remaining tool types are equally often made out of northern flint with bryozoans. The same applies to the choice of blank; in general more flakes are used as blanks, yet the arrowheads are preferably made out of blades and scrapers out of flakes. The selection of better quality blades for certain tool types has already been attested at older Swifterbant sites. The same accounts for the selection of blanks. The projectile points comprise 36 trapezes, 7 triangles with surface retouch, 1 leaf-shaped point, 1 C-point, and 1 backed bladelet. The latter two must belong to the Mesolithic occupation phase, whereas the triangles with surface retouch and the leaf-shaped point may belong to a younger phase than the Swifterbant phase. Flint hammerstones and a few small polished flint axe fragments were retrieved as well.

Just as with the stone artefacts, where the origin could not be traced back to the Swifterbant occupation layer with absolute certainty, this discrepancy is attested for the flint artefacts as well. The blade-flake ratio of 1:4.0 points to a further evolution and thus maybe a Late Swifterbant occupation phase. The many regular blades may support this. The absence of grinding stones, however, contradicts this assumption. The arrowhead types do not simplify the matter either. Trapezes are found, transverse arrowheads are not. Mesolithic projectile points may suggest that some of these trapezes are of Mesolithic date. The triangles with surface retouch and the leaf-shaped points are additions in the northern cultural sphere during the Late Swifterbant Phase. This may be the only significant and distinguishing factor.

At Emmeloord the stratigraphical disturbance makes a division into different phases for the lithic artefacts nearly impossible. The material was therefore analysed as a whole and prudence is called for when interpreting the data. Just as at Urk, the flint assemblage mainly consists of northern flint from secondary procurement sites. The flint is of rather poor quality and gathered locally or regionally, most likely from the boulder clay outcrops in and around the Noordoostpolder. Some imported southern flint was observed as well.

A large dominance of flakes is attested at the site and these are generally rather small. Combined with the many cores recovered at the site, showing one, two, or more striking platforms with only flake scars, this points to intensive, or possibly even exclusive, flake debitage at the site. The limited amount of blades, however, are rather long and regular, and are produced from good quality flint. Even more, on the site no direct proof of blade production could be attested; again implying they were produced elsewhere. The rejuvenation blade may therefore be brought to the site, as some sort of import product or proof of accomplishment or skill, just as the large crested blade found at site S3. It appears that the increasing use of flakes finds its culminating point in this late phase at Emmeloord and Urk. The limited amount of 'imported' regular blades, a tendency already known from earlier Swifterbant phases, points to their considerable decrease in number during this late phase.

The tools were also nearly exclusively made on flakes. The toolkit consists mainly of retouched pieces and to a much lesser extent of scrapers, borers, arrowheads and strike-a-lights; even flint hammerstones and a small fragment of a polished flint axe have been found. The projectile points are mainly triangular arrowheads with covering surface retouch but also a barbed arrowhead. Along with a Scandinavian dagger, some of these tools clearly do not belong to the Swifterbant occupation phase. The arrowhead types are typical for Late Neolithic / Early Bronze Age contexts. Therefore, presumably no arrowhead types belong to the Swifterbant phase, not even the triangular ones. Even more, trapezes or transverse arrowheads, characteristic for the IJssel/Vecht/Eem river basins during the middle Swifterbant phase, have not been found either.

Yet, it may be clear that the flint assemblages of Urk and Emmeloord are very similar, suggesting typological and technological cohesion in this last and small surviving occupation area during the late Swifterbant phase. Many of these characteristics have already been attested at older Swifterbant sites implying a long cultural tradition in the flint industry.

Synthesis

Although the 1600 years of Swifterbant flint history start at Polderweg and De Bruin, the similarities between Hoge Vaart and Swifterbant are more evident. One of the main reasons for the divergence between De Bruin / Polderweg on one hand and Hoge Vaart / Swifterbant on the other hand is the choice of raw material and their procurement sites. At Polderweg small nodules were gathered from secondary deposits in the Meuse valley or from the Meuse deposits in the middle of the Netherlands, while at De Bruin small nodules of both southern and northern flint were selected, in combination with Wommersom quartzite. The small size of the nodules must have been largely responsible for the intensive use of flake debitage, as proven by the large amount of cortex still present. It is only from the third occupation phase onwards (4700 – 4450 cal BC) that a few large, imported Rijckholt blades were introduced at De Bruin. This suggests that all other blanks at De Bruin / Polderweg, even the increasing number of blades during phase 3 at De Bruin, were probably produced on the sites itself.

At Hoge Vaart mainly northern flint is used, with a small admixture of southern flint.[51] The flint nodules were most likely gathered at the Utrechtse Heuvelrug and the Veluwe, a clear difference to the Swifterbant type site where only northern flint from the boulder clay outcrops was observed. Flint technology at Hoge Vaart is characterised by one debitage system focused on the production of regular blades. Flakes were produced, but even if they are present in larger numbers, they should be considered a by-product of the blade production.

The main connection between Hoge Vaart and Swifterbant is the further development of some aspects of the debitage system. While debitage at the levee sites forms one system, based on smaller nodules of somewhat lesser quality knapped in a somewhat ad hoc technique, the development lies within the second, separate system of producing large, regular blades. The production of these blades by specialised or skilled people at an 'off-site' location is clearly based on the operational chain already present at Hoge Vaart (see section 6.2.4). Yet, at Swifterbant this technique appears to be improved or at least systematically used. Possibly this regular blade production is a step taken towards advanced flint specialisation as for example seen in the production of sickles or even flint daggers during the Late Neolithic. Alternatively, the character of the everyday debitage system used at Swifterbant is rather ad hoc which possibly makes the regular blades stand out more easily than at Hoge Vaart. Still the point remains that in the course of the Neolithic and the Bronze Age gradual the flint specialisation goes hand is hand with a gradual degradation in the everyday flint production.

By the time of the middle Swifterbant phase the production of regular blades was also taken up in the Rhine/

51 The excavation also yielded one bladelet of Wommersom quartzite.

Meuse basin, especially at the Hazendonk site. Whether this was a foreign influence of the Michelsberg culture in the south, as seen at Brandwijk, or a domestic influence from the Swifterbant site in the north is open to debate. Nonetheless, the number of flakes increasingly dominate the flint assemblage.

This tendency is also observed at Emmeloord, where no indications of blade production have been found on the site. The regular blades, made of good quality flint, must therefore have been imported to the site from somewhere else. Just as for Swifterbant, it is argued that this does not need to imply transportation over long distances; possibly the blades were made at the procurement site of the better quality nodules in the vicinity of Emmeloord. At Urk two different knapping techniques were attested. Flakes were produced with hard, direct percussion while blades were produced with indirect or direct soft percussion. Most likely, this must also have been the case at Swifterbant as similar lengths and raw material types were attested.

The comparison between the different Swifterbant sites in means of artefact categories and their percentages is not as accurate as one would want them to be. Therefore, only general tendencies will be discussed. As all is related to the excavation techniques and the typological division, sites analysed in similar ways will lead to the best results. To eliminate some of the influence of the excavation techniques the artefacts < 1 cm will not be taken into account.

De Bruin and Polderweg have a very similar division in artefact categories as the debitage material forms the principal artefact group, followed by the waste material while the percentage of tools is rather low. This image, and especially the percentage of tools, is similar to Swifterbant site S3 (8% - 9%). At Hoge Vaart and Doel the debitage material is even more dominant, in spite of the waste material, while tools occur in elevated percentages, especially at Hoge Vaart. Similar percentages may been seen between Hoge Vaart and Swifterbant site S2 and S51 on one hand (17% - 19%), and Doel and Swifterbant site S4 on the other (10% - 11%). It appears the function of the site is decisive in this matter.

During the third occupation phase of De Bruin roughly the same distribution is visible as during phase 2, yet with a light elevation of tools. Brandwijk layer 30 shows similar percentages, although if one more tool had been retrieved from the site, the percentage of the tools would rise to 17% which is in concordance with Hoge Vaart or Swifterbant site S2. This limited sample is therefore not as reliable.

During the middle Swifterbant phase, the division within the artefact categories at Brandwijk layers 50-60 appears to be the same as during the early phase. Therefore, in both phases, the site is interpreted as hunting and/or fishing camp. However, the percentages are similar to Swifterbant site S4, possibly suggesting more extended stays than previously assumed.

The comparison between Urk and Emmeloord is more problematic as the chips are included within the flakes enlarging the fraction of the debitage material. However, it is presumably realistic that Emmeloord shows a very low number of tools while Urk has percentages nearly as high as Hoge Vaart and Swifterbant site S2. Even though Urk is interpreted as a base camp, the typological composition is very similar to Swifterbant S2. Even more, they have a cemetery in common. The low number of tools at Emmeloord is harder to explain. Such a low number is not attested on any other Swifterbant site. Whether the eroded character of the site or the excavation technique had any influence in the matter is hard to determine. It may even be that the fishing activities were mainly carried out with organic tools.

During the whole Swifterbant history the toolkit is focused on retouched pieces, whereas scrapers often take second place. The admixture of other tools, and their percentages, is often low and variable. The relationship between tool typology and their percentages is linked with the function of the site.

The differences between the toolkit at De Bruin and Polderweg are considerable, even though they are both interpreted as base camps. Polderweg focuses on retouched flakes whereas other tools occur rarely, even arrowheads are absent. Yet, we should keep in mind that the sample size is limited. De Bruin also shows a clear predominance of retouched pieces over scrapers, in combination with a whole other array of tools. Even the activities on these two sites are dissimilar. At Polderweg use-wear analysis revealed that tools often showed traces of plant processing, whereas bone and antler processing occurred less, and hide working appeared only once. As evidence of hafting was also found the similarities to Swifterbant sites S3 and S4 are clear. At De Bruin hide working is the main activity while plant processing was encountered far less. Although the differences between these two sites appear even greater than Swifterbant sites S3 and S4, they resemble the combination. It was even attested at De Bruin that the large blades were used for plant processing, just as seen at Swifterbant. As van Gijn stated (van Gijn et al. 2001b: 186) blades are especially selected to perform this task.

The main activity performed at Hoge Vaart clearly translates in the dominance of trapezes. At Doel the retouched pieces only lightly outnumber the scrapers, yet more remarkable is the dominance of retouched blades over retouched flakes, a characteristic even more clearly attestable at Hoge Vaart. This dominance of retouched blades over retouched flakes can also be seen at Swifterbant sites S2, S4 and S51. Even more, the dominance of retouched pieces over scrapers at site S2 is nearly entirely the result of the retouched blades. A clear preference for these regular blades for the performed activities at the site lie at the basis of this. More surprising is the fact that at Swifterbant the dominance of scrapers over retouched pieces occurs at site S4 and S51, even at site S3 they are only lightly outnumbered by the retouched pieces. This is a rare tendency not seen at any other site. The preference for certain types of tools, in this case scrapers, for certain types of activities may be presumed.

The toolkit at Brandwijk layers 50-60 shows a dominance of retouched pieces over scrapers. As nearly no other tools occur in this rather limited set of tools, the percentage of scrapers is elevated compared to for example De Bruin or Polderweg. More remarkable is the percentage of arrowheads. As it nears the percentage at Hoge Vaart, a similar importance of hunting may be suggested at this site.

As the percentage of tools is very low at Emmeloord, it seems to be the odd one out. Even the general division of artefact categories is dissimilar to the other sites. Only a clear dominance of retouched pieces over scrapers and other tools may be attested. Due to its long occupation history, it is also hard to determine what exactly the flake / blade ratio must have been during the Swifterbant, and how many flakes are intrusions from more recent cultures.

The high percentage of tools at Urk is only equalled by that of Hoge Vaart, yet very few arrowheads were retrieved from Urk. The slight dominance of retouched pieces over scrapers is similar to Swifterbant site S3, while the clear dominance of retouched blades over retouched flakes is nowhere as pronounced as here, not even at Hoge Vaart or Doel.

At the start of the Swifterbant culture arrowheads and projectile points are a combination of microliths with trapezes and transverse arrowheads. The presence of the typical Mesolithic microlithic tool types may indicate continuity between the two phases. As microliths no longer occur at De Bruin phase 3 and Brandwijk layer 30 it may be debated upon whether the presence of microliths may be the result of the admixture of Mesolithic material or whether microliths still occurred in the earliest stages of the Swifterbant culture. Yet, the sheer number of microliths, for example 28 at De Bruin, suggests that they did. Another interesting aspect is the fact that the analysed trapezes at De Bruin were not used as projectile points but were used for cutting and scraping (siliceous) plant material (van Gijn et al. 2001b: 184). Whether this points to a prior use of the used blanks, as seen on some of the Swifterbant tools, or to the true nature of the trapezes is unclear.

During the middle phase the arrowhead types at Swifterbant still consist of trapezes and transverse arrowheads; the dominance in terms of percentage of trapezes over transverse arrowheads persists throughout the whole Swifterbant culture. On the sites in the Rhine/Meuse basin they change to drop- and leaf shaped arrowheads (Brandwijk layer 50 – 60), in combination with triangular arrowheads (Hazendonk). The influence of the Michelsberg culture has already been put forward by many researchers in the past.

By the time of the late Swifterbant phase, the territory was shrunk to the IJssel/Vecht/Eem river system. Trapezes and transverse arrowheads were still used as arrowhead types, while sites belonging to the Hazendonk Group still relied on leaf-shaped and triangular arrowhead points. As it was established that at Urk no occupation could have occurred after the Late Swifterbant phase, the leaf-shaped and triangular arrowheads can be nothing else than Swifterbant. Yet, in the subsequent TRB culture such arrowhead types do not occur.

Just as with the polished stone axes, the polished flint axes are encountered from the occupation of Swifterbant onwards. They are present on sites S3 and site S4, yet not observed at sites S2 and S51. During this middle Swifterbant phase fragments of polished flint axes are also seen at Brandwijk, where they occur from layer 50 onwards and at Hazendonk where they occur from layer 1 onwards. Louwe Kooijmans places the introduction of polished flint axes at around 4100 cal BC (Louwe Kooijmans 2005: 260). As Swifterbant sites S3 and S4 are inhabited between c. 4300 – 3950 cal BC, this date might possibly have to be pushed back a little. During the late Swifterbant phase polished flint axes were still in circulation, they were found at Schipluiden and Ypenburg, and also at Urk and Emmeloord.

Another remarkable aspect is the small size of the fragments present at Swifterbant. Only little fragments, mainly smaller pieces of debitage material, occur, whereas at later sites such as Hazendonk 3, Schipluiden, and Ypenburg the fragments are much larger and more substantial existing of semi-intact specimens in combination with debitage material. It is assumed the polished flint axes were brought to the site as intact pieces. Once they became unusable as a tool they were re-used as cores (Houkes 2008a: 225). As at Swifterbant only smaller pieces occur, it is presumed the polished flint axes could not have been used as tools, but were immediately used as debitage material[52], the form in which they arrived at the site. Possibly the larger distance to the source area is of influence here as the presence of smaller fragments has also been attested at Urk and Emmeloord.

Although bipolar pieces, or splintered pieces, do not occur often at the different Swifterbant sites, the bipolar technique was used from the early phase onwards. One of the best ways to 'open' a Meuse egg is to place it on an anvil and split it in half. Another way to start debitage is to 'decapitate' the little nodules by a single blow in order to

52 The question whether these artefacts were indeed used as debitage material, for example as a flake to scrape hides, or whether they should be regarded as ritual deposits, is open to debate. Even the presence of use-wear traces may not resolve this issue.

install a simple platform. The first technique was applied to the Meuse eggs at De Bruin (van Gijn et al. 2001b: 164), while both techniques were applied to the Meuse eggs at Polderweg (van Gijn et al. 2001a: 133)[53]. Clearly the bipolar technique was only, or nearly exclusively, used for debitage purposes as only one splintered piece was found at De Bruin. Even more, the bipolar technique was in the early Swifterbant phase presumably only used on Meuse eggs, as it was not applied at Hoge Vaart or Doel, two sites where Meuse eggs were not found. However, two bipolar pieces were recovered from Doel.

During the middle Swifterbant phase, the bipolar technique is abundantly applied at the levee sites of Swifterbant, where also numerous bipolar pieces, including splintered pieces, were recovered. Their number at the levee sites is quite high, especially at site S3. Even at trench S21-S24 bipolar pieces have been found. As their number at sites S3 and S4 was higher than the retouched pieces, their presence was probably linked to a certain activity mainly performed at the base camp. However, it makes one wonder which activity would be so unique that it was mainly performed at the Swifterbant type site. Unfortunately, use-wear analysis could not provide the necessary answers.

In the publication on Brandwijk (Raemaekers 1999) no comment is made on the bipolar technique; however, as Meuse eggs are present in layer 30 and layer 50 base it is possible the technique was applied. Additionally, no bipolar pieces were mentioned. As the information on the flint assemblage of Hazendonk is even more limited, it is unclear whether Meuse eggs were present in the first place.

At the late Swifterbant site Urk at least 31 bipolar flakes were counted, which is 1% of all the flakes. However, no mention is made of bipolar pieces. At Emmeloord neither Meuse eggs nor the bipolar technique have been mentioned.

The typological term “artefacts with visual use-wear traces” is used in only half on the sites under consideration. At Hoge Vaart, Doel, Urk and Emmeloord they are catalogued as a separate type. Their amount is generally low (c. 1%), only at Hoge Vaart was the percentage similar to those at Swifterbant sites S2, S4 and S51 (c. 6%). The importance of regular blades at these sites is at the centre of this whereas site function and activities appear to be linked. The processing of (fresh) hide and (soft) siliceous plant materials are important tasks at these sites, while bone / antler and wood working were attested to a lesser extent. This analysis proves once more that regular blades were clearly selected to perform certain tasks, and specifically plant processing (van Gijn et al. 2001b: 186).

The amount of chips or artefacts < 1 cm per site is not easily compared as their number is strongly dependent on the excavation technique. Additionally, the limit of length between smaller and larger artefacts is set in this research at 1 cm, while this is for example 5 mm at De Bruin and Polderweg. At Emmeloord and Urk, the artefact type was not even used in the typology. There even seems to be no relationship between the occurrence of large amounts of grit and large amounts of chips. For example, large amounts of chips have been attested at De Bruin, yet hardly any were recovered from Hoge Vaart where the presence of grit was clearly attested. Even more, the largest amount of chips is found at Doel where only a few handfuls of stone artefacts were found.

A final aspect to be considered is the heat exposure. At De Bruin phase 2 up to 36% of the assemblage showed traces of heat exposure, and even up to 43% for phase 3. The amount of heat exposed artefacts from phase 2 is roughly similar to that of Swifterbant sites S3 and S4 (30% and 34%), while the 43% of phase 3 is not as elevated as the large amount of heat exposed artefacts at Swifterbant site S2 (52%). At Polderweg only a part of the material was analysed on heat exposure, of this material 13 % was visibly exposed to heat. Of the sample of flint artefacts at Hoge Vaart 18% showed traces of heat exposure. Both appear rather low compared to Swifterbant. The information on the artefacts of Doel is somewhat more detailed. Heat exposure is observed for 33% of the material. Heavy heat exposure occurs the most, an aspect also seen at Hoge Vaart, yet at Swifterbant all levee sites show a dominance of medium heat exposure. This discrepancy is not yet fully understood and requires more research (see section 6.3.11). At Doel it was also attested that tools are less often exposed to heat compared to the debitage material, an aspect seen on nearly all levee sites.

The different occupation phases of Brandwijk show diverse percentages ranging from 26% for layer 30 to 39% - 44% in layers 50 – 60. At Emmeloord the percentage of heat exposed artefacts is 33%, while this is 25% at Urk. An aspect observed in this research and also analysed by Verneau (2001: 94) is the fact that heat exposure clearly leads to fragmentation.

6.3.10 Stone, flint, and pottery: a comparison of percentages

The comparative percentages of stone and flint artefacts over the different sites at Swifterbant appear to vary. Stone artefacts dominate over flint on sites S2 and S4, while flint is more abundantly present at S3 and trenches S21-S24. At sites S51 and S61some sort of equilibrium is attested. When pottery is taken into the equation, the differences become even larger as the lithic artefacts are clearly outnumbered at sites S2 and S51, whereas pottery is nearly absent at levee site S4. The low amount of pottery at site

53 Although it is not explicitly mentioned, it is presumed these techniques were applied to the Meuse eggs from all occupation phases.

S61 and trenches S21-S24 is less surprising because of the long Mesolithic occupation.

At all the other Swifterbant sites flint always outnumbers the stone artefacts, even at De Bruin and Emmeloord where fair amounts of stone artefacts were retrieved. The high percentage of pottery observed at Swifterbant sites S2 and S51, could also be observed at Brandwijk and Urk. However, this image is distorted as the stone artefacts are not included in the equation. Presumably this view is more biased at Urk than at Brandwijk, as at the latter the amount of stone artefacts is said to be very low (pers. comm. D. Raemaekers 2009). The only similarity between Brandwijk and Swifterbant sites S2 and S51 appears to be the fact they are interpreted as hunting camps or special activity sites, and not as base camps. Whether this implies the same set of activities is unclear as use-wear analysis was not conducted at Brandwijk.

Thus, the sheer amount of stone artefacts present at the Swifterbant type site, 36303 in total, has not been rivalled by any other site. When only the larger artefacts from the levee sites at Swifterbant are taken into account to exclude differences in excavation techniques and selection method, the assemblages at De Bruin slightly outnumber those at Swifterbant. Whether this manipulation of numbers is representative is another question.

6.3.11 Aspects of interest and topics for future research

Fragmentation

One of the most intriguing aspects not yet fully understood, nor explained for that matter, is the presence of large numbers of flint chips at certain sites, for example at Swifterbant sites S4 and S61, but also at De Bruin. One of the explanations given by the researchers at De Bruin is the fact that many large artefacts were transported to the twin site of Polderweg after they were produced at De Bruin. This would indeed result in large amounts of chips and small amounts of larger artefacts. Yet, it should also result in large amounts of rejuvenation material and cores, something that was not observed. Of course, as these are also larger artefacts, their transportation may have been a fact as well.

Another explanation for high numbers of small artefacts is the fragmentation of artefacts due to heat exposure and possibly even trampling. Even though trampling and /or tillaging are recorded at sites S2, S3 and S4 (Huisman et al. 2009, Huisman & Raemaekers in prep.), and high percentages of heat exposed material was observed at site S2, the largest amounts of grit have been attested at sites S4 and S61. Differences in degree of fragmentation were also observed for the bone material. The animal remains of site S2 were subject to heavier fragmentation than the material of site S3 even before inundation. However, there may have been many different causes for that (see Prummel et al. 2009: 33).

Other aspects that may influence the difference in percentages of flint chips or stone grit between the various levee sites at Swifterbant are differences is knapping techniques or the excavation of different areas. It is to be expected that the excavation of a knapping area will result in a higher percentage of chips than an isolated activity area. It may be clear that different causes lie at the bottom of this phenomenon on which, based on the current data, cannot be further pronounced upon.

Heat exposure

Four intriguing aspects of heat exposure have been observed at the different sites at Swifterbant. First, it was observed that on all sites with a cemetery the levels of heat exposed artefacts were elevated. This is especially so for site S2, but also for site S4 and trenches S21-S24. Whether these two aspects are related or not is at first sight not really clear especially as, for example, the contemporaneity between the lithic material and the cemetery at site S2 could only partially be corroborated. However, at Urk, the only other Swifterbant site with a cemetery, the levels of heat exposure are of a more ‘normal’ level.

This leads us to the second issue. Many differences between sites S2 and S3 can be put forward, for example, the presence and absence of clay floors. Would it be possible that the absence of clay floors, which are present on site S3, allows the heat to penetrate better into the soil resulting in more burnt artefacts? Alternatively, the ‘damp’ living conditions at site S3 might have ‘prevented’ the heat exposure to some extent. As site S3 is located lower than S2, it is presumed to have wetter living conditions or at least more damp living conditions. Whether this necessitated the use of many bundles of reed and twigs to keep the settlement dry, or whether the bundles were brought to the site for another purpose is irrelevant here. Their presence at least required the construction of clay floors to build a fire. As site S2 consists of much drier living conditions, reed bundles were not necessary, or at least not applied, neither were clay floors, resulting in a far less humic occupation layer that was also much thinner. The site may therefore have been more subject to trampling than site S3. The high fragmentation rate of flint blades at site S2, also observed for the animal bone remains, may therefore indirectly be a result of the drier living conditions. Even more, the high frequency of heat exposure, observed again for flint and bone material, may indirectly be a result of the absence of clay floors. Additionally, heat exposure of flint leads to fragmentation.

The third issue is the impression that flint recovered from a sandy soil (trench S23) is often more heavily exposed to heat than flint recovered from clay soils that predominantly show traces of medium heat exposure (sites S2, S3, S4 and S51). Could it be that soil type has any influence on the degree of heat exposure of flint artefacts or at least that flint is more easily exposed to higher temperatures because of the sand? Thus, is sand a better heat conductor than clay?

The fourth aspect may be related to the former. It appears that fine-grained flint with bryozoans burns more easily than fine-grained flint without bryozoans, or at least shows more signs or reacts quicker. This is a weighty statement but it is observed that when the numbers or percentages of heat exposed artefacts is low, the percentage of heat exposed fine-grained flint without bryozoans stays the same whereas that of the fine-grained flint with bryozoans is elevated (see section 5.3.4).

Bipolar technique

Bipolar pieces made of flint are frequently found at Swifterbant, and also at other Neolithic sites in the Netherlands. This clearly proves that the bipolar technique was fully controlled and that tools produced in this manner were often needed and used by proving their functionality. Yet, why is the bipolar technique, so popular with the flint artefacts, not applied to the stone artefacts? Especially since stone artefacts in Scandinavia are frequently knapped in this way?

Functionality of combination tools

The experimental reproduction of use-wear traces on stone tools can provide better insights in the way certain tools were used. For example, the presence of random impact traces on tools' surfaces in this research is often seen as the result of their use as hammerstones (see paragraph 3.3.). The presence of random impact traces on larger cobbles should perhaps be revised, especially when they occur on a larger anvil / hammerstone combination as on site S51. The artefact is quite massive measuring 130x76x59 mm and weighing 617.5 g. To create random impact traces as the result of a hammerstone function this object needs to be lifted, maybe above the head, and struck down. To have done this repeatedly must have been very tiring. Secondly, the large surface of the artefact allows its user to steady his hand not only on the rim of the artefact, but also more to the middle or other part of the surface. This would result not only in grouped impact traces in the middle of the surface but also in random traces. Thus the artefact may have been used only as an anvil. Other functions may also have led to random impact traces, such as the production of flakes out of discarded old tools, or even pecking and roughening. More experiments with replica tools might provide a better insight into the origin of certain use-wear traces.

On the same matter, experiments might reveal the purpose of the anvil pit in anvil / grinding stone combinations. This is a tool combination that is often observed, and not only in Swifterbant contexts, but also on other Neolithic sites. The possible interpretation given in this research, i.e. the 'capture' of cereal grains in the "anvil pit" of handstones in order to grind the cereal more easily on the flat surface of the netherstones needs to be tested in archaeological experiments. Only then can the validity of this hypothesis be assessed.

Use-wear analysis

As with a handful of other studies, this research has shown that use-wear analysis on stone tools contributes largely to the understanding of these tools' functions and usability. Yet, this research is relatively recently-developed and certainly not wide spread. Therefore, I would like to argue that in the future more stone tools are subjected to at least use-wear analysis, and by extension residue analysis. This research revealed that topics of interest are polishers and grinding stones on the one hand, and all different types of axes (including shoe-last axes and shaft-hole axes) on the other. Although it is clear these tools are used, the contact material is often still not determinable. More elaborate research, and especially experimental research, is required. Related topics of interest might be the orientation of the grinding direction with querns and grinding stones versus polishers, i.e. the loss of crystals and minerals during usage, and the use and contact material of seemingly 'un-used' flakes.

Residue analysis

Although the residue analysis in this research only revealed the presence of phytoliths, the research is believed to provide more insight in the functions of tools. All analysed grinding stones revealed smaller or larger amounts of fragmented phytoliths. As both soil samples were packed with undamaged phytoliths it is highly unlikely the phytoliths ended up in 'pores' of the grinding tools during their interment. Yet, to establish this with certainty future research should also include polishers in the residue analysis. It would possibly also reveal other contact materials such as colourants or other mineral substances used.

Size of nodules

At trenches S21-S24 it was attested that the only nodule which was measured during the detailed analysis of the sampled material, was one of the largest found at the Swifterbant site (82x54x51 mm). Other large nodules of c. 7 cm have been found on sites S41 and S80-S82, whereas the largest nodule was found on site S3 (102x82x45 mm). It would appear that during the habitation on the dunes, in the Mesolithic, as well as during the Neolithic, on the levee sites, large nodules were available. Yet, the 'off-site' production, i.e. a production elsewhere, of large regular blades, in combination with the 'on-site' technique of using small nodules for 'everyday' debitage and tools, suggests large nodules were treated differently.

Therefore, when the flint artefacts from trenches S11-S13 are returned from the University of Michigan (Ann Arbor), and when they are studied in detail with all the remaining material from trenches S21-S24, particular interest should be given to the size of the nodules.

Flint type of regular blades

The final observation regards to the raw material type of the regular blades. Based on a visual inspection of the 'regular blades' and the 'irregular blades' no difference in colour or texture could be defined. It would therefore appear that the regular blades are produced from the same type of flint as the irregular blades, only of a bigger size, suggesting similar procurement sites. However, as this distinction is based on recognisability, it is not as reliable as the distinction between, for example, flint and Wommersom quartzite. Further (chemical) analysis might shed some light on this matter.

Chapter 7

Conclusions, the key to Neolithic Swifterbant

7.1 Introduction

Nobody ever expected that the closing of the dikes, carried out in order to reclaim parts of the IJsselmeer, would form the start of a whole new archaeological chapter. Nevertheless, the pedological and geological inspections of the newly dug parcel ditches in the regained land not only revealed a submerged system of creeks and levees with numeral archaeological sites but also led to the recognition of a whole new prehistoric culture.

It is a long time since the Swifterbant culture was seen as a variant or a derivative of the Ertebølle culture. Nowadays, the Swifterbant culture is considered to be the Western counterpart of the Ertebølle culture, separated by their own characteristics and related only in some general aspects. These general aspects are maybe no more than the spirit of the age. The Swifterbant culture appears to have been a cultural group between the Ertebølle culture in the north and the LBK to the south. The differences between their Mesolithic and Neolithic ways of life were too big to reconcile in one wave (Raemaekers 1999: 191). It is safe to say the Swifterbant culture is acknowledged as a separate culture with its own characteristics and may be seen as a conductor between the Mesolithic and the 'new' Neolithic.

In the course of this research, different aspects of the Swifterbant culture have been analysed, with a clear emphasis on the lithic industry. Chronological developments and cultural inheritance have been presented throughout the past few chapters; facts have been listed and comparisons have been made. This chapter, however, is a more personal interpretation of the facts at hand. An impression is given of what everyday life may have been like at the Swifterbant type site during the few hundred years the levee sites were occupied (c. 4300 – 4000 cal BC).

7.2 Raw material procurement and mobility

Although the site territory was the focal point of everyday life, the Swifterbant people were dependant on a much larger area for their overall survival. Raw materials needed to be brought in from distant procurement sites, food was gathered from areas with seasonal resources, and family and cultural ties were tightened when certain areas were visited.

The mobility area is divided into several activity zones with different radiuses. Beyond the camp zone, i.e. immediate surroundings of the base camp, lies the daily activity radius or site territory (foraging zone) for daily subsistence and activities such as gathering food and other resources. The logistical zone reaches up to a 30 km boundary while the year territory (extended zone) of the group or family comprise the different settlements or camps visited within a one year cycle. The final radius is the sphere of influence (visiting zone), the range of expeditions and the network of contacts as seen in the exchange of exotic materials (Bakels 1978, Binford 1982, Houtsma et al. 1996, Higgs & Vita Finzi 1972, Louwe Kooijmans 2001a, Newell et al. 1990, also see section 4.8.4).

The Swifterbant site is not to be interpreted as one specific spot; it comprises many different occupation areas spread out over a fair part of the creek system. As the site is interpreted as some sort of patchwork, it comprises the site territory, i.e. the area around the site that is normally exploited by the inhabitants. The site territory did not only include several different levee sites but also the river dunes present in the wider creek system. It must be mentioned that not all levees were inhabited at the same time or with the same intensity, they were not even used for the same activities (see below). Even though food was readily available in this area, and partly cultivated by the Swifterbant people themselves, certain raw materials were gathered farther from home. Places at 5 to 10 km from the site are considered to belong to the site territory or foraging zone as they can be exploited in a one day trip journey while areas farther away may be interpreted as belonging to the logistical zone or even the year territory (Vita Finzi & Higgs 1970, Higgs 1975, Binford 1982, Louwe Kooijmans 2001a, Andersen 1994).

The logistical zone and the year territory beyond reached at least from the boulder clay outcrops at Urk and Schokland in the north to the Veluwe and the Utrechtse Heuvelrug in the south. The first two are 10 and 14 km from Swifterbant, putting them at the edge of the site territory or just beyond, while the latter two are located some 30 or 40 km away at a full day's travel from Swifterbant. The boulder clay outcrops were the primary source for stone artefacts whereas the Veluwe and the Utrechtse Heuvelrug formed a supplementary yet well considered source of a specific type of resource. Flint was exclusively gathered at the boulder clay outcrops. The only other source of flint is the polished flint axes imported from areas 100-150 km to the south or southeast, probably acquired from farming communities such as Rössen or one of its descendants. Along with a few other raw materials, some of which may be found as far as 250-330 km from the site (the Ardennes in Belgium or the Boulonnais region in France), these are seen as non-local and/or exotic imported products. They were probably not gathered by the Swifterbant people themselves but most likely acquired by gift exchange, or some other form of long distance trade or travel. This signifies the largest activity radius, also known as the sphere of influence.

In the early Swifterbant phase this sphere of influence reached similar distances to the south, but it stretched to different places. Artefacts made of Wommersom quartzite, a raw material only to be found near Tienen in Belgium, were found at Doel, De Bruin and Hoge Vaart. They occur in decreasing amounts at these sites as each site is located farther to the north. From the middle Swifterbant phase onwards this supply seemed to have faded or exchange relations altered as no artefacts of such material were found at Swifterbant. In this respect, the Swifterbant culture resembles the general trend in the Netherlands that the exploitation of Wommersom quartzite was greatest in the Late Mesolithic and diminished during the early stages of the Neolithic. It must, however, be mentioned that a very similar raw material type, a brown translucent quartzite of a somewhat coarse-grained texture, was observed in very small amounts at Swifterbant. The source of this raw material is currently unknown.

The northern boundary of the sphere of influence is a different matter. In the early Swifterbant phase the most northern site was Hoge Vaart. At that time, the Veluwe was the preferred procurement area to gather flint. During the middle phase this procurement area was still in use for certain rock types, whereas flint was gathered more to the north at the boulder clay outcrops. It seems the northern shift in the territory dates from that time.

The boulder clay outcrops must have been vital procurement areas as there is no stone material naturally occurring in the soil in or around Swifterbant. The rocks needed to be gathered at Urk or Schokland, most easily accessible by water either to the east or to the west. The eastern connection would have been shorter but involved a crossing of dry land as the Eem and the Vecht river systems are not connected to each other, whereas the western water connection involved a longer trip around the coast. Even though this must have put a certain strain on the supply of lithic material the amount of stone artefacts at the Swifterbant site is overwhelming compared to the other Swifterbant sites. The only exception is possibly De Bruin where a fair amount of stone artefacts has been found. This limit on the supply of stone blanks might have encouraged the Swifterbant people to re-use old, broken and discarded artefacts and tools. This is not only observed for flint tools like scrapers, which have been resharpened after breakage, but also for numerous stone tools.

Another aspect of this restricted supply is the conscious selection of certain types of blanks at the procurement sites. This is especially so for heavy artefacts like the stone tools; it is hardly observed for flint nodules or tools. Cobbles of a specific shape, weight, and rock type were chosen, most likely with a specific function in mind. A different combination of characteristics was preferred for specific tools, i.e. the blanks chosen for hammerstones are different from those to be chosen as grinding stones.

Aspects such as proximity and accessibility are inextricably linked to territory, mobility, and raw material procurement. The amount of a specific type of artefact diminishes as the distance to the procurement sites of the raw material increases. The number of amber beads and pendants, compared to jet and shale pendants, is overwhelming. This is different in the middle of the Netherlands where jet outnumbers amber as blanks for ornaments. Although social and cultural links may naturally follow from this line of argument (see below) some aspects are not as clear cut as one would like them to be. Two raw material types are frequently chosen for ornaments at Swifterbant, i.e. amber lumps and stone flat pebbles. The flat pebbles were personally gathered from the Meuse deposits in the middle of the Netherlands and turned into pendants at the Swifterbant site. Their procurement site falls within the year territory. The amber ornaments were presumably imported to the Swifterbant site as finished products from the northwestern coast of the Netherlands, not personally gathered or produced. It is possible the northwest coast did not belong to the Swifterbant year territory and amber pendants and beads were attained by gift exchange or some other form of trade within the sphere of influence. Then again, it cannot be ruled out that the coast did belong to the Swifterbant year territory and the pendants were brought to the site as finished products in the same way as the regular blades, which were personally produced yet not at the site, but at the procurement site of the raw material. Either way, it points to the special value of amber within the Swifterbant society.

7.3 Social and cultural indicators

The Swifterbant site must have been inhabited by (extended) family groups. This is suggested by the composition of the cemeteries, the composition of the organic and inorganic tools, and the wide variety of the activities performed.

Research at the different cemeteries at Swifterbant not only reveal the mixed composition in age and sex of the buried people but also that they were related. Rare dental anomalies have shown the buried people to belong to the same family. The graves point to the interment of different generations over several decades, yet the graves only occasionally spatially overlap. It is not hard to imagine that succeeding generations lived at Swifterbant and revisited the site during their lives. It is only just a small step further to interpret the rich graves of man and woman as successive leaders. Although this interpretation is highly speculative it is based on certain facts. Although most people are buried without any apparent grave goods or possessions, a limited number shows a certain wealth of imperishable artefacts. The ornaments from the adult man in grave IX (site S2) are the most diverse in raw material type and comprise the largest lumps of amber. The same was observed at the burial site of Urk, where the man also wore his large, amber ornaments on a string around the head, one of the most visible parts of the body often chosen for displaying social markers. The woman at Swifterbant in grave V (site S2) was buried with a larger number of ornaments than the man from grave IX, yet of smaller size and only of one type of raw material, amber. The head of the women in grave I (site S22) was buried along with a jet pendant, the only jet artefact found at Swifterbant. As this type of raw material is of southern origin, and is more common in the middle of the Netherlands, this pendant is of a different origin than the amber ornaments. It is likely that the woman too came from outside the area (see Raemaekers et al. 2009, Smit & van der Plicht 2009) as it is argued in this study that the ornaments buried with the deceased are their personal belongings. The objects were possibly even a marker of status or social difference already present at birth as the child from site S4 was buried with its own amber pendant. As the pendant showed only traces of minor wear, it was clearly not a family heirloom.

The special significance given to the amber ornaments in graves is somewhat contradictory to the large number of such ornaments that appear to have been abandoned or lost in in the cultural layer of site S3. If amber ornaments were as highly valued as we might think, people would be more careful not to lose them. At the same time, the occupation at site S3 might have been sufficiently long that an occasional loss of one pendant added up to a large amount of artefacts over time. Even more, as the site is the main settlement site (see below) loss of ornaments is more common than at the levees used as special activity sites.

Most of the ornaments discussed above are made out of non-local materials such as amber, jet, and shale, but also from certain types of flat pebbles. The presence of amber, or any other type of non-local raw material, does not necessarily imply the import of these materials, it could merely indicate external contacts (van Gijn 2006). Whether these external contacts are in the form of special expeditions intended to procure the material, and thus a reflection of the mobility area, or whether these contacts are in the form of (gift-) exchange with neighbouring groups, and thus a reflection of the sphere of influence, cannot at present be determined. The current research however suggests that at Swifterbant amber, jet, and shale were most likely imported as finished products, whereas stone pebbles were gathered personally.

Another type of pendant, although not discussed in this research in detail, are animal teeth pendants (see Devriendt 2008c). These are seen as a cultural inheritance of the Swifterbant people's Mesolithic ancestors. Teeth of cattle, wild boar, pig, horse, otter, and dog were perforated through the root and worn. In the absence of unfinished pendants, it is presumed that these teeth pendants were not produced at the Swifterbant site itself (see section 4.8.2). However, animal teeth without any visible traces of processing were found. Whether these are raw material for the production of pendants or just offal, is open to debate. The fact remains that animal teeth were perforated and used as pendants and beads, and that other teeth remained unaltered. An interesting observation here is the presence of beaver teeth at Swifterbant. The large incisors may have been used as pendants or to carve wood (Osgood 1940, Clark 1975). These teeth have also been found at Polderweg, De Bruin, and Emmeloord. Yet, only at the latter site, was proof found that these teeth were worn as pendants. As with the jet pendant, a difference in social markers or cultural preferences may be at the bottom of this.

Amber grave goods are known from a number of sites in southern Scandinavia (Kannegaard Nielsen 1990, Larsson 2001). Yet, all in all amber ornaments in graves are rather rare. Mostly animal teeth are used while shells, bones, and different kinds of stone occur occasionally (Grünberg 2000). In the Netherlands amber is found in graves from Urk, Schipluiden, Ypenburg, and from the megalithic tombs of the TRB culture. The amber ornaments in the graves at Swifterbant are thus the oldest in the Netherlands, in the absence of finds contexts from the Mesolithic such as seen in Scandinavia.

In conclusion, the presence of the numerous unfinished stone pendants and the total lack of unfinished amber or animal teeth pendants, support the idea that amber and animal teeth ornaments were imported to the sites as finished products. However, this does not immediately need to imply long distance transportation. Stone ornament production is clearly demonstrated at sites S2, S3, and possibly site S4. Jet and shale ornaments may however have been imported. The local production of stone ornaments proves that there were prolonged periods of habitation as the ornaments were made, worn, discarded, lost, and buried with the deceased at the sites. The ornaments are seen as the personal belongings of the wearer, possibly as an indicator of social identity, status or wealth or maybe even ethnicity.

7.4 Settlement system

One of the main characteristics of the Swifterbant type site is the differentiation of the diverse loci. The area known as the Swifterbant site comprises several levees and river dunes within a larger creek system. All these different 'sites' are part of the site territory. Both levees and river dunes were used or inhabited in the same period of time. This simultaneity is, however, somewhat relative. First of all, not all levees and river dunes were used at exactly the same time or with the same intensity. Different combinations of certain levees with certain river dunes must have occurred, just as some levees were used more intensively, and for different purposes, than others. Yet, the time span of contemporaneity cannot have been large as refits between fragments of tools have been found connecting levees to river dunes and levees between themselves, especially when one realises that flooding was a regular and reoccurring aspect of the levee sites.

Even though research at the Swifterbant type site started more than 30 years ago, the interpretation of the different loci is still on going as recent research initiatives reveal new information. In the past, the different levees and river dunes were regarded as separate entities. But it is now clear that they are part of a larger site territory, and even a larger settlement system, and are all (very) different from one another.

The presence of a house of c. 4.5x8 m on site S3 was established by de Roever (2004). Yet, the different phases of the house were not clearly revealed until the spatial analysis of the lithic artefacts in this study. It is now clear that site S3 was the central settlement site or base camp in the area during different occupation phases. The house and central hearth indicate the residential character of the site whereas the amount and composition of organic and inorganic artefacts and tools point to many different household activities including flint knapping, hide working, plant and food processing, fire making, and all kinds of repair work on organic and inorganic materials.

This research established that the composition of the lithic artefacts and tools on site S4 is very similar to that of site S3 making an interpretation as annexe to the base camp very plausible. Activities must have been very similar, yet the presence of a house has not been corroborated. Other small differences between site S3 and S4 must have been present as a burial occurred on the latter and not on the first. Recently, evidence was found that site S4 was not only used as a cemetery, but also as a hoe-field for cereal production. At first glance this is also a differentiating factor from site S3. However, it is also confirmed that originally site S3 and site S4 were one site, but that after a while one part was cut off from the other by a creek. This implies, and is recently corroborated, that site S3, and even site S2, may also have been used as hoe-field (Huisman et al. 2009, Huisman & Raemaekers in prep.). Even though this cereal production may have had the form of gardening, it is more than originally accepted on these small levees which were presumed to be too small and wet to sustain any form of cereal production. It also implies that cereal cultivation may have been more common and widespread than originally presumed. It is therefore possible that even more levee sites at Swifterbant were used as a hoe-field at one time or another.

Another aspect setting site S4 apart from site S3 is the number of small lithic artefacts. Numerous of flint chips and stone grit point to a high fragmentation rate, and possibly to different activities, at least to a certain degree. This high percentage of smaller artefacts was also observed at Swifterbant site S61 and at De Bruin. At De Bruin this was probably due to a lack of bigger artefacts. It is presumed that larger artefacts were produced at De Bruin but were subsequently transported to Polderweg. Considering the amount of larger artefacts at site S4 this is, however, unlikely to have been the case at Swifterbant. Some material may have shifted from site S4 to site S3, probably not an uncommon practice as refits occur between several other sites.

Certain similarities between two sites were also observed at sites S2 and S51, although they differ from sites S3 and S4. First of all, they both are located quite separately in different parts of the creek system. The most obvious differentiating factor at site S2 is the large cemetery. More characteristics seem different however, the composition of the flint artefacts and tools for example. The substantial presence of large, regular blades suggests that a specific set of activities took place on the site. In combination with a large number of grinding stones this would imply it was a special activity site. To what extent these activities are similar to those performed at site S51 is hard to determine as parts of that site have been eroded.

It may be clear that the different levee and river dune sites at Swifterbant fulfilled different needs but whether one was more important than the other is probably a modern question and not so much prehistoric fact. As the levees and river dunes were all part of the site territory, and were used for different purposes, it is presumed that they all formed an intrinsic part within the larger whole. One may have been more important for ritual purposes, while another was vital for food production. Over time, activities probably shifted from one site to another, yet not all activities were performed at all sites. Possibly certain activities, for example ritual activities or the presence of a burial site, ruled out other activities.

7.5 Technology

7.5.1 Stone industry

The amount of stone artefacts at Swifterbant is immense compared to the other Swifterbant sites, or many other Stone Age sites in the Netherlands for that matter. Of course one may speculate that the occupation history of the site, encompassing a few hundred years, might easily have resulted in the gradual accumulation of the c. 40.000 pieces of stone, all together weighing 250 kg. However, if the number is compared to the amount of flint artefacts, it may be clear that this site is quite different from the others.

The stone industry is made up of two essential components. On the one hand, there is a large amount of debitage material and on the other a vast set of tools produced out of cobbles. Just as with the flint industry, the first set is characterised by flakes and blades, and even cores. Strangely enough, none of these have been visibly altered into tools such as one would do with flint blanks. Therefore it would appear that the many rocks, mainly of different types of quartzitic sandstone, have been knapped precisely to produce flakes and blades, and that these appear to have been used unaltered, a practice of which evidence was found at Schipluiden (van Gijn & Houkes 2006). This technique is often employed at the Swifterbant type site yet rarely observed at any other Swifterbant site. A lack of thorough research into the stone industry and the absence of extensive stone assemblages at those sites may be part of this image. Yet its significant presence at Swifterbant may point to a different cultural setting or an adaption to specific environmental characteristics which would enable the Swifterbant people to perform different activities at these sites, possibly with adapted sets of tools.

The second essential component of the stone industry, the tools made out of cobbles, are, like the flakes and blades, used in an unaltered way. Cobbles and pebbles were not transformed into the desired shape; they were hand-picked at the procurement sites based on their existing shape, texture, and raw material type, in order to avoid unnecessary time investment. Weight and size must have been very important discriminating factors as well. All these aspects were taken into account when selecting a specific cobble. As these discriminating factors are different per tool type the selector needed to have a specific tool in mind while choosing the cobble.

Therefore, it may be concluded that the technology used to produce stone tools at Swifterbant is kept to a minimum. This does not necessarily have to mean the Swifterbant people did not possess such knowledge or skill, it merely indicates an opportunistic way of using naturally occurring cobbles and a very efficient time investment system.

The absence of modelling stone tools may have been compensated for by technological innovation. It was observed that certain of the handheld grinding stones have a pit in the middle of the grinding surface. Possibly the pit was created to 'capture' the cereal in order to grind it more easily on the flat surface of the netherstones. The use as anvil creates a similar kind of pit which might have triggered the idea.

However, certain artefacts seem to express a limited knowledge of stone tooling. For instance, the use of a hollow drill instead of a solid drill was not yet taken up. This is exemplified not only by the stone pendants and beads, but also by the local copies of shaft-hole axes. Two specimens of the latter have been recovered from the Swifterbant site. Both are characterised by an hourglass shaped perforation produced by pecking and/or a solid drill. However, more remarkable is the tilted position of the cutting edge in comparison to the perforation. Some people thought that these characteristics would have resulted in the axes being unusable and were possibly to be interpreted as a lack of skill. Yet, as the use of the axes was proven, and seeing the limited time investment in stone tool modelling in general, the use of a right sized and shaped cobble as a blank for the axe, most likely resulted in the general shape of one of the axes. The other axe is clearly more modelled by grinding and polishing yet still shows a tilted cutting edge.

Another aspect mainly observed within the stone industry is the deliberate fragmentation of tools. More specifically, grinding stones have been subject to deliberate fragmentation in exponential numbers compared to other stone tools. This fragmentation was especially attested at site S2, where a large number of long, regular blades were also broken. This deliberate destruction may not only be limited to a specific tool but also to a certain site, area, activity, or maybe even a ritual, as site S2 is one of the few sites characterised by a cemetery.

Whether the higher fragmentation rate of the artefacts at De Bruin, in comparison with those at Polderweg, must be seen in this respect as well is not at all clear. The presence of a much larger number of flint chips and small fragments at De Bruin may rather be connected with the relocation of larger artefacts from De Bruin to Polderweg. Additionally, the overwhelming amount of flint chips, compared to larger flint artefacts, was also observed at Swifterbant sites S4 and S61.

7.5.2 Flint industry

The second component of the lithic industry is the flint assemblage, together with the stone artefacts forming an intrinsic part of the prehistoric toolkit. As with many other Stone Age sites, the flint material has in the past been studied more extensively than the stone artefacts. However, different as they may seem at first glance, their joint analysis reveals much more than either would reveal by itself.

The flint assemblage at Swifterbant is characterised by two technical signatures. The first consists of a flake technology on small nodules whereas the second is a regular blade technique on much larger cores. Another essential difference between the two is the location of their production (figure 7.1).

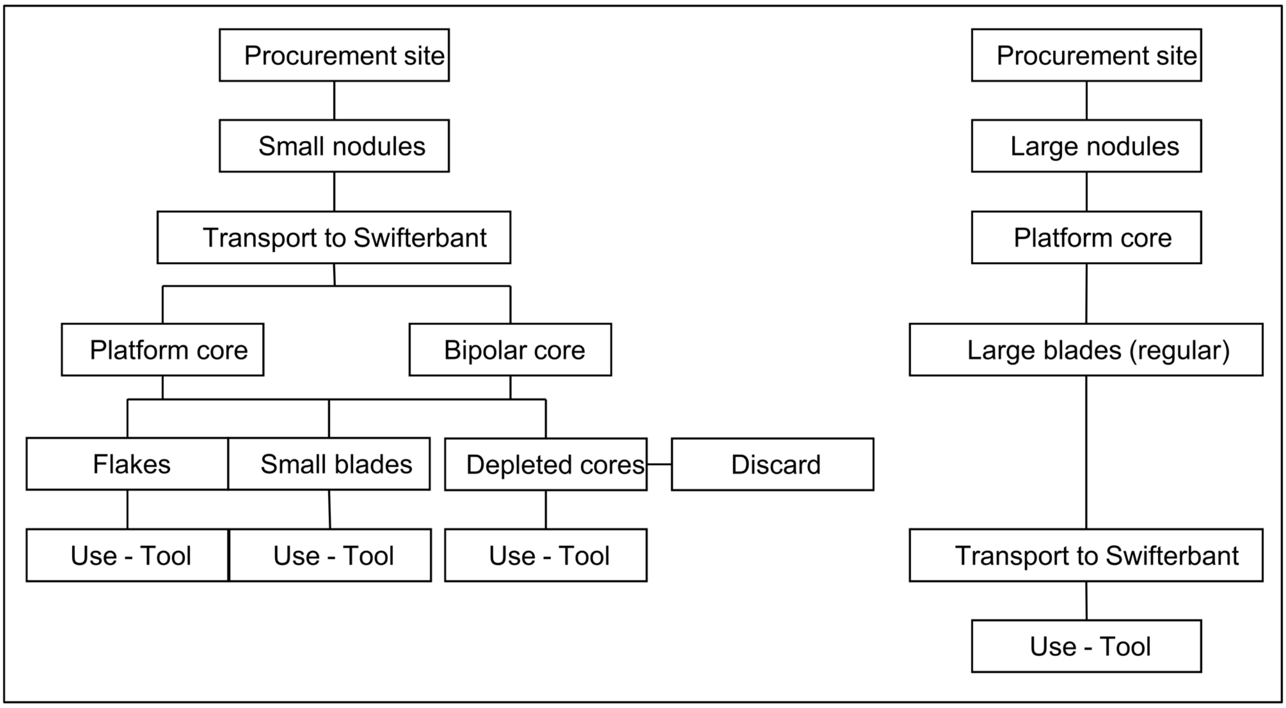

Figure 7.1 The flint production sequences present at Swifterbant.

The first debitage technique is applied at the site itself. It is based on the use of small nodules, which are knapped with a simple technique that requires little or no maintenance of the core and striking platforms. This technique results mainly in flakes, and to a lesser extent in small blades, used as blanks for the production of tools for everyday activities at the sites.

The second debitage technique is not applied at the site itself. It is currently unclear where the large, regular blades were produced as their production site has not yet been discovered. However, as the flint nodules used for this technique have the same physical characteristics as the smaller nodules, except for their size, similar procurement sites are presumed. Therefore, the location of the production site may be in the vicinity of the Swifterbant site or the boulder clay outcrops of, for example, Urk and Schokland.

This research also revealed that tool blank selection was more well-considered than at first presumed and that these two distinct sets of tool blanks were used for different purposes. The locally produced flakes and blades were transformed into everyday tools at the moment they were needed at the site. A selection on size and type of blank was made to produce certain types of tools, a characteristic already observed at Hoge Vaart and Doel. The large, regular blades were, however, only used on certain Swifterbant loci and presumably for specific purposes and activities.

The use of large, regular blades, not produced on site but brought in from somewhere else as finished products, is observed at Hoge Vaart and Doel. It is also still applied at Emmeloord. This technique is a Mesolithic inheritance, just as the use of Wommersom quartzite and different types of microliths. As the latter two occur at Hoge Vaart and Doel, yet are no longer observed at Swifterbant, it appears that certain Mesolithic practices went out of use while others persisted to the very end of the Swifterbant culture.

Most peculiar is the absence of these large, regular blades at Polderweg and De Bruin. Even more, they do not even occur at Brandwijk. It appears that during the middle phase this absence of large blades at Brandwijk was counterbalanced by the import of large artefacts made of Rijckholt flint from Michelsberg areas, whereas in the early Swifterbant phase they simply did not exist. This would suggest that larger nodules were absent or unattainable in the larger area around the Alblasserwaard (i.e. Polderweg, De Bruin, and Brandwijk) and that it was only possible to produce small flakes and blades at the sites themselves from small sized nodules. It is, however, unclear how the blade production at Hazendonk fits in with the absence of such a technique at the other sites in the region (see section 6.3.9).

The presence of these two, co-existing techniques suggests that simple flint knapping was a necessary skill known to everyone at the site, but elaborate knapping, required to produce regular, large blades may have been a specialised skill known only by a few. Whether this blade production needed the seclusion of the production site or whether it was simply more convenient to knap those large nodules at their procurement site, may only be answered when such a production site is discovered.

The single large crested blade with rounded tip found at Swifterbant, and a similar find at Emmeloord, may be interpreted in relation to this. As it is likely that anyone at the site was able to produce flakes and blades of small dimensions to provide in their own need to produce everyday tools, the ability to exceed these limited knapping skills and fabricate large, crested blades would have been quite an accomplishment. Both artefacts should therefore be interpreted as some sort of trophy, proof of rite of passage, or evidence of technical skill and ability.

Another distinct difference between the sites in the Rhine / Meuse river systems and those in the IJssel/Vecht/Eem river systems is the types of arrowheads. Under the influence of the Michelsberg culture the preferred arrowhead types in the middle of the Netherlands are leaf- and drop shaped arrowheads, while trapezes are the typical type in the northern regions. At Swifterbant, few of the latter are defined as transverse arrowheads, yet these are technically misshaped trapezes. They are for example different from the transverse arrowheads seen in the TRB culture.

7.6 Final provision

When it is stated that the stone artefacts form an intrinsic part of the whole of the lithic industry in prehistoric cultures, it sounds self-evident. Yet, the overwhelming interest and research into flint assemblages often makes the stone industry second best, especially in the Low Countries. It is true that the number of stone artefacts at sites in The Netherlands and Belgium is often to be neglected in comparison to flint artefacts, and that traces of use are often rare, but this does not justify their neglect during research.

This study has revealed that stone industries are just as regulated by raw material type, morphological characteristics, technical boundaries and typological organisation as flint industries are. They should therefore be analysed as often and as thoroughly as flint assemblages are. Even though stone artefacts have been in recent years more often analysed than a decade ago, systematic analyses by research standards and techniques equal to flint analyses should be maintained, and should be expanded to all prehistoric sites, as there are still so many things to be discovered and unravelled.

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Samenvatting

Dit onderzoek richt zich op de natuurstenen en vuursteen artefacten van de vindplaats Swifterbant. De aandacht gaat voornamelijk uit naar de neolithische bewoningsfase van dit prehistorisch krekensysteem (ca. 4000 – 4300 v. Chr.) waar resten van bewoningsporen op verschillende oeverwallen en rivierduinen zijn aangetroffen. Na uitvoerige opgravingen in de jaren 1960 tot 1980 heeft het Nieuwe Swifterbant Project (vanaf 2004) een nieuw elan gegeven aan het onderzoek naar deze vindplaats die zijn naam gaf aan een prehistorische cultuur, de Swifterbant-cultuur. Het belang van deze vindplaats is dan ook niet te onderschatten en verder onderzoek naar de lithische artefacten was hoognodig.

Hoofdstuk 1 introduceert het onderzoek. Eerst worden de onderzoekshiaten in het oude, reeds bestaande onderzoek belicht, waarna het nieuwe onderzoek algemeen geschetst wordt. Dit doctoraatsonderzoek past namelijk binnen het Nieuwe Swifterbant Project dat in 2004 is opgestart. Het nieuwe project wil meer inzicht verwerven in de bewoningsactiviteiten en het landschapsgebruik en –dynamiek in en rondom Swifterbant. Ook controleert het of de huidige beschermingsmaatregelen voldoende zijn om de vindplaats te vrijwaren voor de toekomst. Als derde punt worden de onderzoeksmotivaties en –doelstellingen gepresenteerd waarbij het gebrek aan (gedetailleerd) onderzoek naar de natuurstenen en vuurstenen artefacten het meest voor de hand liggende aspect is. Uit een tweede grote lacune, namelijk het gebrek aan intra- en intersite analyses, vloeit voort dat in het verleden de vindplaatsen te Swifterbant steeds als aparte entiteiten werden bekeken en nooit het groter geheel, of het verschil onderling, naar voor kwam. Dit onderzoek probeert ook deze lacune in te vullen. De methodes hiervoor zijn divers, gaande van een typologisch onderzoek van alle lithische vondsten, over een technologische attributenanalyse en een onderzoek naar grondstofgebruik, tot meer gespecialiseerd onderzoek zoals gebruikssporen- en residuanalyse. Als laatste onderdeel van dit hoofdstuk komen de onderzoeksvragen aan bod.

Hoofdstuk 2 geeft, naast algemene informatie over de Swifterbant-cultuur, een gedetailleerd overzicht van de opgravings- en onderzoeksgeschiedenis van de vindplaats zelf, in combinatie met de geologische ontwikkeling en de algemene datering van het onderzoeksgebied.

Zo worden allereerste de verschillende, bestaande definities van de Swifterbant-cultuur besproken. Aangezien deze grotendeels het gevolg zijn van voortzettend onderzoek en nieuw verworven inzichten veranderen deze ook, vaak per nieuw ontdekte vindplaats. Daarna wordt de Swifterbant-cultuur in een ruimer chrono-cultureel kader geplaatst. De ontwikkeling van een keramisch mesolithicum tot een volwaardige neolithische cultuur wordt geschetst tegen een achtergrond die evolueert van de LBK, over Rössen en Bischeim, naar de Michelsberg-cultuur en de Hazendonk-groep. Aansluitend volgt een korte opsomming van de gekende Swifterbant-vindplaatsen.

Als tweede deel van dit hoofdstuk komt de lange onderzoeksgeschiedenis van de vindplaats Swifterbant aan bod. Dit gedeelte is grotendeels gebaseerd op de oude opgravingen tussen 1964 en 1979 en de oude publicaties uitgegeven tussen 1972 en 1986. De gegevens uit nieuwe opgravingen en publicaties, ruwweg te dateren tussen 2000 en 2012, zullen beperkt besproken worden.

In hoofdstuk 3 neemt de analyse een aanvang met de presentatie van de methodologie, de beperkingen van het onderzoek en de voorstelling van enkele algemene observaties. De analyse van de natuurstenen artefacten wordt uitgevoerd in drie fasen. Fase 1 is gebaseerd op een indeling van de artefacten volgens gewicht. Zo worden artefacten lichter dan 3 gram met een beperkte set aan variabelen geanalyseerd, terwijl de artefacten gelijk aan of zwaarder dan 3 gram met een uitgebreide set aan variabelen worden onderzocht. In fase 2 worden bepaalde artefacten, zoals werktuigen en ornamenten, op gedetailleerde wijze beschreven en verder bekeken op details en technologische kenmerken. Uiteindelijk wordt in fase 3 de data verwerkt en worden de resultaten met elkaar vergeleken, zowel op intrasite als op intersite niveau. Voor de vuurstenen artefacten is dit driefasig systeem zeer gelijkaardig met het verschil dat hier de grens tussen de kleine en grote artefacten bepaald wordt op basis van de lengte van het artefact gemeten volgens de afslagas. De grens is in dit proefschrift op 1 cm gelegd.

Eén van de voornaamste beperkingen van het onderzoek is de gefragmenteerde staat van de bestaande onderzoeksgegevens. Na meer dan 40 jaar onderzoek zijn oude gegevens vaak niet meer toegankelijk. Zo zijn bijvoorbeeld de ruimtelijke gegevens van bijna alle artefacten verloren gegaan. Andere onderzoeksbeperking hebben betrekking op het materiaal zelf. We denken hier aan de blootstelling van de artefacten aan hitte en verbranding maar ook aan het al dan niet gebruiken van een microscoop als werkmethode. Ook andere problemen worden aangekaart. Binnen het onderzoek naar lithische vondstcomplexen is er reeds lang discussie over bepaalde onderwerpen. Drie van deze onderwerpen worden hier besproken aangezien ze van toepassing zijn op dit proefschrift. Het betreft ten eerste bipolaire stukken en het gebruik van de bipolaire techniek, ten tweede het voorkomen van afgeronde uiteinden van vuurstenen artefacten en werktuigen, de zogenaamde afgeronde stukken, en ten derde de problematiek rond gepolijste bijlen.

Het hoofdstuk wordt afgesloten met enkele algemene observaties over de natuurstenen en vuurstenen vondsten. Voor de eerste groep komen de volgende onderwerpen aan bod: de toegepaste verzamelwijze van een deel van het materiaal, allerlei bemerkingen aangaande de artefacten kleiner dan 3 gram, 'erratic debitage', de afwezigheid van verfrissingsmateriaal, werktuigclassificatie en –terminologie, verkleuring versus blootstelling aan hitte en verbranding, de variabiliteit van impactpunten, gefragmenteerde wrijfstenen versus wrijfsteenfragmenten en de typologie van ornamenten. Voor de vuurstenen artefacten komen de volgende onderwerpen aan bod: het voorkomen van retouches op proximale en distale uiteinden, observaties ten aanzien van het verschil tussen geretoucheerde stukken en artefacten met zichtbare gebruikssporen maar ook tussen verfrissingsmateriaal en klingen, en tussen chips en microchips, om af te ronden met waarnemingen over de blootstelling van artefacten aan hitte of verbranding en de gevolgen voor de textuur van het oppervlak.

Hoofdstuk 4 is gericht op de natuurstenen artefacten. Onderzoeksaspecten zoals werktuigmorfologie, grondstofgebruik en –toegang, technologische productiesequenties en werktuigfuncties komen aan bod. Dit gebeurt aan de hand van een bespreking van alle vondsten per vindplaats (S2, S3, S4, S21-S24, S41, S51, S61 en S80-S84). In totaal zijn ruwweg 36.000 artefacten geanalyseerd, goed voor ongeveer 200 kg. Het dient vermeld te worden dat deze uiteenzetting een korte weergave is van het gedetailleerde hoofdstuk dat in de catalogus aanwezig is (catalogus hoofdstuk 1).

Na de bespreking per vindplaats komen enkele deelanalyses aan bod. Het gedeelte over het grondstofgebruik geeft een voorstelling van de verschillende grondstoffen en hun herkomstgebieden, zoals de keileem, de Utrechtse heuvelrug, de Veluwe en de maasterrassen. Maar ook het gebruik van barnsteen, git, schalie en pyriet / marcasiet wordt voorgesteld, en dit met hun desbetreffende herkomstgebieden. Een ander deelaspect van het onderzoek is een refittingsonderzoek. Een kleinschalig onderzoek dat niet alleen heeft aangetoond dat artefacten of fragmenten binnen eenzelfde vindplaats aan elkaar kunnen gepast worden, bijvoorbeeld door de aanwezigheid van drie sequentiële afslagen, maar dat ook fragmenten over verschillende vindplaatsen heen aan elkaar blijken te passen. De (relatieve) gelijktijdigheid van de bewoning op de verschillende vindplaatsen lijkt hiermee bewezen. Een derde deelanalyse, een gebruikssporenonderzoek, is uitgevoerd door derden maar geïntegreerd in dit proefschrift. Wrijfstenen van vindplaatsen S2, S3 en S4, en gepolijste bijlfragmenten van vindplaatsen S3 en S51, zijn geanalyseerd. Zo blijkt dat de wrijfstenen bijna allemaal gebruikt te zijn voor het verwerken van plantaardig materiaal, mogelijk graan. Een combinatie van wrijfrichtingen is vastgesteld, bijvoorbeeld in de lengterichting, maar ook dat er vaak gewreven wordt mee met de richting van de gelaagdheid van de steen. De analyse van de bijlfragmenten was gericht op de vraag of bijlen met een schuin geplaatste snede bruikbaar zijn en of vastgesteld kon worden waarvoor ze gebruikt werden. Het belangrijkste resultaat is dat beide fragmenten wel degelijk gebruikt waren, maar dat het contactmateriaal niet vastgesteld kon worden. Als laatste is ook een barnstenen hanger op sporen van gebruik gecontroleerd. De belangrijkste conclusie die hier getrokken kan worden, is het feit dat hangers en kralen gezien moeten worden als de persoonlijke bezittingen van de drager. Een tweede onderzoek uitgevoerd door derden, is de residuanalyse. Deze heeft de hierboven vermelde vraagstelling rond de aard van het plantaardig materiaal, i.e. wilde grassoorten of vroege cultivars, niet kunnen oplossen. Wel blijkt de hoeveelheid phytolieten afhankelijk te zijn van het type werktuig, loper versus ligger, en van de intensiteit waarmee deze gebruikt zijn. Als beide analyses met elkaar gecombineerd worden, dan blijkt dat wrijfstenen op de verschillende vindplaatsen toch op eenzelfde manier gebruikt zijn, voor dezelfde soorten gewassen. Van enkele vindplaatsen, van site S3 in het bijzonder, zijn de ruimtelijke gegevens van de vondsten bewaard gebleven. Door het in kaart brengen van de kleine en grote artefacten, en het plotten van de werktuigen, zijn enkele activiteitzones aangetoond maar de belangrijkste verdienste van dit deel van het onderzoek is wel het in beeld brengen van de verschillende bewoningsfasen van het reeds gekende huis.

Tot slot worden in de conclusie de gegevens van alle vindplaatsen bij elkaar gebracht. Eén van de voornaamste conclusies is dat de natuurstenen artefacten en werktuigen het resultaat zijn van het selectief verzamelen in de herkomstgebieden. Stenen van een specifieke vorm, gewicht en grondstof werden uitgezocht. Naar gelang welk werktuig men voor ogen had, werd er gezocht naar een andere combinatie van kenmerken. Deze kenmerken zijn per werktuigtype opgesomd. Een ander interessant aspect is het hergebruik van werktuigen en de fragmentatie ervan. Zo blijkt dat wrijfstenen vijf keer vaker gefragmenteerd zijn dan andere werktuigtypen. Ook bij de gepolijste bijlen is een opmerkelijke tendens vastgesteld. Naast geïmporteerde bijlen komen ook lokale kopieën voor die gekenmerkt worden door een schuin gepositioneerde snede. Een laatste belangrijke conclusie is dat hoewel natuurstenen hangers op de vindplaatsen zelf vervaardigd zijn, de barnstenen hangers en kralen als afgewerkte importproducten kunnen beschouwd worden. Daarenboven wijst het onderzoek uit dat deze ornamenten de persoonlijke bezittingen van de drager zijn, en mogelijk een weerspiegeling zijn van leeftijd, geslacht, sociale identiteit, status of zelfs etniciteit.

Hoofdstuk 5 focust op de vuurstenen artefacten. Hier komen grotendeels dezelfde onderzoeksaspecten als voor de natuurstenen artefacten aan bod. Deze analyse gebeurt aan de hand van een bespreking van alle vondsten per vindplaats (S2, S3, S4, S21-S24, S41, S51, S61 en S80-S84). In totaal zijn ruwweg 88.500 artefacten geanalyseerd (70 kg), echter wel aan de hand van verschillende onderzoeksniveaus. Het dient vermeld te worden dat deze uiteenzetting een korte weergave is van het gedetailleerde hoofdstuk dat in de catalogus aanwezig is (catalogus hoofdstuk 2).

Net als bij de natuurstenen artefacten, komen na de besprekingen per vindplaats enkele deelanalyses aan bod. Het gedeelte over het grondstofgebruik analyseert de verschillende types vuursteen en de aanwezigheid van cortex en patina. Als herkomstgebied wordt de keileem aangeduid, met Urk en Schokland als de meest waarschijnlijke ontsluitingen. Daarenboven blijkt dat de gepolijste vuurstenen bijlen niet als een complementaire bron van vuursteen moeten gezien worden, maar eerder te interpreteren zijn als zeldzame, geïmporteerde fragmenten. Een ander deelaspect van het onderzoek is een gebruikssporenanalyse, ook hier uitgevoerd door derden en geïntegreerd in het proefschrift. Zowel de oude (1985) als de nieuwe (2006-2007) analyses worden besproken. Beide onderzoeken combineren een selectie van artefacten en werktuigen van vindplaatsen S2, S3, S4, S51 en S61. Het betreft niet enkel klingen en klingen met zichtbare gebruikssporen maar ook bipolaire en afgeronde stukken. De belangrijkste conclusies zijn dat op de verschillende vindplaatsen een waaier aan activiteiten is uitgevoerd, met plant- en huidbewerking als voornaamste. Als belangrijke opmerking wordt gesteld dat de afwezigheid van sikkels, i.e. klingen met een typische sikkelglans, niet per se hoeft te betekenen dat er geen graan geoogst werd; dit kan ook op een andere manier zijn uitgevoerd. Een ander, niet onbelangrijk deelonderzoek is de technologische attributenanalyse. Deze analyse naar de productiesequenties van de vuursteenassemblage is uitgevoerd op artefacten van vindplaatsen S2, S3 en S61. Na een theoretische inleiding volgt de uiteenzetting van de gebruikte methodologie. Daarna wordt de data per attribuut gepresenteerd. Voor de afslagen en klingen zijn bijvoorbeeld de lengtekromming, de aflijning van de zijden (boorden), de vorm van de doorsnede en het dorsaal ribbenpatroon in kaart gebracht. Ook is er aandacht voor de morfologie en de afmetingen van het slagvlakrestant en de slagbult. Maar de analyse reikt verder dan dat; ook kernen en bipolaire stukken zijn op technologische kenmerken onderzocht. Kenmerkend voor vindplaatsen S2 en S3 is de productie van afslagen en klingen op kleine kernen. De kernvoorbereiding is zeer beperkt, en meestal zijn slechts een handvol afslagen per kern gemaakt. Ook kernvernieuwing is beperkt; de kerntafel wordt onderhouden door de kern een kwartslag of een halve slag te draaien. De successratio waarmee bipolaire stukken worden bewerkt, toont aan dat de bipolaire techniek een beter aangepaste techniek is voor het debiteren van kleine kernen. Net als bij de natuurstenen vondsten zijn van enkele vindplaatsen, en van site S3 in het bijzonder, de ruimtelijke gegevens bewaard gebleven. Toch zijn verspreidingspatronen diffuser en conclusies moeilijker te maken dan bij de natuurstenen artefacten. Wel zijn ook hier weer de verschillende bewoningsfasen van het reeds gekende huis in beeld gebracht.

Tot slot worden in de conclusie de gegevens van alle vindplaatsen bij elkaar gebracht. De voornaamste conclusie is de aanwezigheid van twee, naast elkaar toegepaste, debitagetechnieken. Op de vindplaats wordt een soort "huis-, tuin- en keukentechniek" toegepast die vermoedelijk beheerst werd door alle leden van een familie. Zoals hierboven gezegd gaat het om kleine kernen die op een ad hoc wijze bewerkt worden, zonder al te veel kernvoorbereiding of –verfrissing. Op deze manier kon iedereen voorzien in zijn eigen behoefte aan dagelijkse werktuigen. Daarnaast komen op de vindplaats grote, regelmatig geproduceerde klingen voor die duidelijk elders vervaardigd zijn en als afgewerkte producten naar Swifterbant zijn gebracht. Het wordt in dit onderzoek gesteld dat deze klingen vervaardigd kunnen zijn door gespecialiseerde of bepaalde, vakkundig bedreven mensen.

Hoofdstuk 6 brengt alle informatie samen. Hierdoor kan per vindplaats een uitspraak gedaan worden over de vermoedelijke functie ervan. Bij de voornaamste conclusies hoort dat vindplaats S3 als het basiskamp (*settlement site*) geïnterpreteerd kan worden, met vindplaats S4 als een soort annex, terwijl vindplaatsen S2 en S51 eerder speciale activiteitszones zijn (*special activity site*). De overige oeverwallen en rivierduinen hebben echter integraal deel uitgemaakt van het groter nederzettingsgebied en vormen een bonte verzameling aan locaties met verschillende functies.

In het tweede deel van het hoofdstuk worden ook andere Swifterbant-vindplaatsen die relevant zijn voor dit onderzoek besproken. Het betreft Hardinxveld-Giessendam Polderweg, Hardinxveld-Giessendam De Bruin, Almere Hoge Vaart, Doel, Brandwijk, Hazendonk, Urk en Emmeloord.

Uiteindelijk worden alle aspecten van de verschillende Swifterbant-vindplaatsen bij elkaar gebracht in een chronologisch overzicht onderverdeeld per onderwerp. Aspecten als chronologie en datering, vindplaatslocatie en –functie, maar ook voedselvoorziening en de archeologische resten (organisch materiaal en aardewerk) komen aan bod. De aandacht gaat echter voor het grootste deel uit naar de natuursteen- en vuursteenindustrie.

Het laatste hoofdstuk 7 is een synthese. Hier wordt een interpretatie gegeven van het alledaagse leven in prehistorisch Swifterbant in de paar honderd jaar dat de oeverwallen bewoond waren. Ook hier is dit gedaan aan de hand van enkele centrale thema's zoals grondstofgebruik en mobiliteit, sociale en culturele markers, nederzettingssystemen en de kenmerken van de lithische vondstcomplexen.

Appendix 1

Variables and definitions of lithic analysis

1.1 Definitions used for stone artefact analysis

1.1.1 Definition of primary classification

As mentioned in chapter 3 (section 3.1.2), the primary classification is the subdivision between artefacts lighter than 3 gram (< 3 g) and those equal or heavier than 3 gram (≥ 3 g). The artefacts < 3 g are per definition pieces of waste lighter than 3 g. Of course, this group is more diverse than only pieces of waste. They can be flakes of which the butt and bulb are partially or fully weathered or removed (by accident or on purpose) and consequently are no longer definable as a flake. They can also be flakes or flake fragments without a clear dorsal or ventral face which gives them the characteristics of waste. Therefore, a definition as waste lighter than 3 g is preferred. Only when pieces < 3 g show clear features typical for certain artefact categories other than waste, they are treated as such and transferred to the group of artefacts ≥ 3 g. In that case, typology is more important than weight. The artefacts ≥ 3 g are studied in detail and are subject to typological and technological analyses.

1.1.2 Definition of variables

Artefacts ≥ 3 g

For the artefacts ≥ 3 g the following variables are registered:

- Artefact type
- Type of blank
- Fragmentation
- Weathering
- Stone type
- Origin
- Degree of burning
- Dimensions
- Weight
- Refitting possibilities
- Special characteristics

– Artefact type: the type of artefact based on the following typological list:

Table 1.1 Artefact type

1	Indeterminate fragments
2	Indeterminate fragments with retouch
3	Polished fragment
4	Pebble or cobble
5	Frost flake or pot-lid
6	Indeterminate fragment with flake scar or debitage traces
7	Core
8	Flake
9	Tool on flake or blade
10	Polished flake
11	Blade
12	Rejuvenation piece
13	Polished axe
14	Polished axe fragment
15	Hammerstone / grinding stone
16	Handstone
17	Netherstone
18	Hammerstone
19	Anvil
20	Anvil / hammerstone
21	Anvil / grinding stone
22	Hammerstone / anvil / grinding stone
23	Whetstone
24	Flat pebble
25	Chip
26	Possible debitage material
37	Pendant
38	Unfinished pendant
39	Bead
40	Others

Specific artefact types are grouped in artefact categories. The debitage material comprises flakes (8), blades (11), chips (25), rejuvenation pieces (12), and cores (6, 7). The groups of tools (2, 3, 9, 10, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23) and ornaments (37, 38, 39) are self-evident. The waste material combines undefined fragments (1), frost flakes and potlids (5), pebbles and cobbles (4, 24), and possible debitage material (26). The last group is defined as others (40) and combines special finds not included in the typological list.

– Type of blank: the type of blank used to produce the artefact.

Table 1.2 Type of blank

1	Pebble or cobble
2	Indeterminate fragment
3	Core
4	Flake
5	Blade

Table 1.2 continued

6	Rejuvenation piece
7	Other
8	Indefinable

– Fragmentation: the degree of completeness of the artefact.

Table 1.3 Fragmentation

1	Complete
2	Damaged
3	Broken
4	Other
5	Not relevant

An artefact is damaged when only a small piece is missing, an artefact is broken when a large part is missing. For some artefact types, such as undefined fragments, this variable is of no relevance. No technical information on the type of fracture is registered. Type nr 4 is an option that was never required in the analysis.

– Weathering: is the artefact covered with traces of physical weathering or chemical weathering?

Table 1.4 Weathering

1	Yes
2	No

Several types of weathering may occur. The first type is physical weathering. Transport of stones from their primary outcrop to a secondary position leaves physical traces. Weathering of the surface resulting in the rounding off of the crystals and surface is one of them. Other processes as frost or moisture have impact on the material as well. The second type is chemical weathering. Chemical processes may interact with the surface of the material, resulting in several types of patina. The third type is weathering due to handling. These are not use-wear traces such as striations but some sort of discolouration. Intensive use of artefacts can result in a brownish patina as if the artefact has become dirty by usage. During the analysis, no distinction has been made between these three types of weathering, nor has there been a registration of the extent of these processes over the artefact. Only the presence or absence is noted down.

– Stone type: the type of raw material the artefact is produced from.

Table 1.5 Stone type.

1	Granite
2	Granite gneiss
3	Syenite / monzonite
4	Diorite
5	Gabbro
6	Aplite
7	Pegmatite
8	Writing granite
9	Porphyry
10	Granite porphyry
11	Rhyolite / quartz porphyry
12	Syenite porphyry
13	Dacite
14	Trachyte
15	Andesite
16	Basalt
17	Diabase / Dolerite
18	Melafphyre
19	Sandstone
20	Quartzitic sandstone
21	Quartzite
22	Conglomeratic sandstone
23	Conglomerate
24	Helleflint
25	Breccia
26	Limestone
27	Quartz
28	Gneiss
29	Amphibolite
30	Schist
31	Granulite (leptite)
32	Slate
33	Pyrite / Marcasite
34	Amber
35	Jet
36	Other

One of the best reference books on stone types in the Netherlands is *Het Keienboek* (Van der Lijn 1923, 1973). This book's classification is applied in this study. Earlier research (Deckers, 1979) proposed the procurement of material from secondary positions at an outcrop of boulder clay nearby the site. None of the material was believed to be retrieved from primary locations. Consequently, this research only focused on the main stone types because the time and effort invested in acquiring the knowledge of subtypes was believed to be not proportional to the extra information it would have given. However, some artefacts have been analysed by Harry Huisman who could give supplementary information on subtype or origin. Harry Huisman is a petrologist and an authority on boulder clay erratics in the Netherlands. He worked in the Museum of Natural History in Groningen for forty years, of which large part as curator, up until it closed at the end of 2007. Currently Harry Huisman works for the University Museum.

With the description of the tools the coarseness of the raw material is also registered. These are:
a) Fine grained: crystals < 1 mm
b) Medium grained: crystals 1-2 mm
c) Coarse grained: crystals > 2 mm

– Origin: earlier research (Deckers, 1979) indicated the extraction of material from secondary positions. The region of origin is therefore not the primary source or outcrop but that of the secondary position in a larger area.

Table 1.6 Origin.

1	Northern (general)
2	Boulder clay - northern
3	Southern (general)
4	Rhine - southern
5	Meuse - southern

– Degree of burning: the degree of heat exposure.

Table 1.7 Degree of burning.

1	Heavily burned - black
2	Not burned
3	Lightly burned - cracks

The degree of burning is determined by the damage or discolouration of the artefact. In this research only traces visible with the naked eye are registered. Alternation by fire is not always clearly visible or distinguishable from other transformations of stone artefacts. The most obvious is the black discolouration due to heavy fire. When the black colour has penetrated the outer surface of the stone and is still visible several millimetres underneath this surface, the artefact is considered to be heavily burned. Differences in partial or full discolouration are only registered for tools. Brown to dark-grey or even black discolouration which does not penetrate the surface is regarded as a patina and therefore not considered to be a result of burning. When there is no fresh plane of fracture present, these two transformations are not always easy to distinguish from each other.

Cracked artefacts or artefacts broken along an irregular plane of fracture with large, irregular hollows are regarded to be lightly burned. It is not always possible to distinguish this alternation from that of frost fissures, weathering or the influence of moisture. When cracks run through crystals instead of alongside them, this is considered to be a result of minor burning. If no visible traces are detected the artefact is defined as not burned.

– Dimensions: the measurements of the artefact, in millimetres (measurements are rounded off to the nearest whole millimetre).

Table 1.8 Dimensions.

1	Length
2	Width
3	Thickness

The measuring of the dimensions of an artefact is determined by the orientation of that artefact. The orientation of an artefact is in its turn determined by the type of that artefact. Flakes and blades are oriented according their debitage axis; this axis is the length. Width is measured transversely to that and thickness is measured perpendicular to that. Cores are measured accordingly but along the debitage axis of their main striking platform.

Several artefact types have no precise orientation such as waste material. These are measured according their morphology; the longest dimension is considered to be the length. The other dimensions are measured transverse and perpendicular to that. The second longest dimension is considered to be the width and the smallest is the thickness.

For the tools two different measuring systems have been applied. For the smaller tools, like scrapers or retouched blades, the same orientation is used as with the unretouched flakes and blades, thus along the debitage axis. The larger tools, like hammerstones, anvils, and grinding stones are oriented and measured according to their morphology.

– Weight: the weight of the stone artefacts is measured to a tenth of a gram precise.
– Refit possibilities: when two or more artefacts can be refitted, this is noted down in this field, along with the corresponding artefacts numbers.
– Special characteristics: any special characteristics an artefact might have are registered here. These can be tool descriptions, special features or other general remarks.

Artefacts < 3 g
For the artefacts < 3 g the following variables are registered:

- Number of artefacts per find number
- Total weight
- Special characteristics

- Number: this variable is only used in the category artefacts < 3 g. It is possible that more than one artefact is retrieved on a certain spot or from a square. They are treated as a whole and not described separately.
- Total weight: this variable is only used in the category artefacts < 3 g. It is possible that more than one artefact is retrieved on a certain spot or from a square. They are treated as a whole and not described separately.
- Special characteristics: any special characteristics an artefact or group of artefacts might have are registered here. These can be special features or other general remarks.

1.1.3 Definition of terminology

Debitage and tool terminology are largely based on Adams (2002), Hamon (2008), and Inizan (et al. 1999).

- Indeterminate fragments: this term should only be used to denote pieces of stone (artefacts) whose mode of fracture or debitage axis cannot be identified and which cannot be designated as any other type of artefact.
- Indeterminate fragments with retouch: an undefined fragment which is intentionally transformed by a removal or a series of specific removals carried out for the purpose of obtaining a tool.
- Polished piece: this is an undefined fragment with a polished surface. Together with polished flakes they form the group of ground stone fragments.
- Pebble or cobble: stone with natural rounded edges and surfaces.
- Frost flake / potlid: a fragment of an artefact detached as the result of frost or heat exposure.
- Indeterminate fragment with flake scar or debitage traces: an undefined fragment with one or two flake scars or other traces of debitage like hammering traces. Retouches are not included in this. They differ from cores because they only have one or two flake scars and lack systematic debitage or striking platform preparation.
- Core: a block of raw material from which flakes, blades, or bladelets have been struck, in a systematic fashion in order to produce blanks for tools.
- Flake: a general term for a fragment of stone that is removed from
    a) a core during its preparation (preparation flake, preliminary flake, etc.)
    b) a cobble, a slab, a core, etc., and if need be fashioned into a tool at a later stage (knapping flake, debitage flake)
    c) a tool during manufacture (retouch flake, shaping flake).

In this study flakes are only defined as such when a clear point of impact is visible with the naked eye or with a magnifying-glass (x10). The bulb has to be visible to some degree, which is however not always the case. Flake fragments are only defined as such when they have a clear ventral and dorsal face with one or more flake scars or when the proximal part is still present, thus the impact point and bulb. If these two conditions are not met, the artefact is defined as possible debitage material. Therefore, the category possible debitage material may contain proximal flake fragment lacking the characteristics described above, medial or distal flake fragments, etc.

- **Tool on flake or blade**: a flake, blade or bladelet which is intentionally transformed by a removal or a series of specific removals carried out for the purpose of obtaining a tool.
- **Polished flake**: a flake with a polished surface as dorsal face.
- **Blade**: a blade is a flake of which the length is at least equal to twice its width. The limit between a blade and a bladelet is determined by length, however in this research no difference has been made. Several authors and researchers make a distinction between true blades and blade-like flakes, a true blade showing traces of previous parallel removals on its dorsal face, and also having more or less parallel ridges and edges. Because of the often coarse-grained character of the stone types and the debitage technique this distinction has not been made. If a regular blade indicating systematic blade production was encountered, this was written down in the Special characteristics box.
- **Rejuvenation material**: a core tablet, flake or blade which is the result of the preparation or maintenance of the core during debitage, which may become necessary when the condition of the striking platform precludes the debitage from being continued.
- **Polished axe (fragment)**: a tool with triangular or trapezoidal shape and a cutting edge, used to fell trees or for woodworking. Other proposed functions are the use as wedge, adze, chisel, and gouge. They can also have a ceremonial or symbolic function.
- **Perforated axe**: an axe with a perforation often oriented parallel to the cutting edge.
- **Anvil**: a block of stone placed on the ground or steadied by other means and used as a solid base for striking a core in order to flake it, striking a chunk of raw material in order to shape it, applying a burin blow to a burin, etc. or for retouching a flake (a blade, a bladelet) with a hand-held hammer.
- **Hammerstone**: a tool used to detach flakes from a core, or for battering and cracking other materials. A small hammerstone, mostly produced of a pebble, may be referred to as a *retouchoir*.
- **Grinding tool**: a tool consisting of a handstone and netherstone used to grind and process foodstuffs, colorants, etc.
- **Hand stone**: the part of the grinding tool used in the hand, also referred to as *mano*. A small grinding stone,

mostly produced of a pebble, may be referred to as a *polisher*.
- **Nether stone**: the part of the grinding tool that rests on the ground, also referred to as *quern* or *metate*.
- **Hammerstone / anvil:** a tool combining characteristics of both a hammerstone and an anvil suggesting a combined use.
- **Hammerstone / grinding stone**: a tool combining characteristics of both a hammerstone and a hand stone suggesting a combined use. This type of stone tool is sometimes referred to as *broyon*.
- **Anvil / grinding stone**: a tool combining characteristics of both an anvil and a grinding stone suggesting a combined use.
- **Hammerstone / anvil /grinding stone**: a tool combining characteristics of a hammerstone, an anvil and a grinding stone suggesting a combined use.
- **Whetstone**: a tool used to for sharpening the blades of tools like axes, knives, and chisels.
- **Flat pebble**: this type of pebble is in Dutch defined as *schuifsteen*. It is a pebble of ordinary size but with a limited thickness of c. 5 mm.
- **Chip**: this is a flake or blade, or fragment thereof, weighing less than 3 g. Because of their small size it is not always possible to determine stone type with 100% certainty. The refit study showed that two chips can sometimes be refitted into a larger piece, for example a whole flake. Chips can thus be flake fragments which weigh too little to be defined as a flake, i.e. ≥ 3 g. This is because the division is based on weight and not on measurements as with the flint analysis.
- **Possible debitage material / tool**: these artefacts are not just undefined fragments but can possibly be pieces of debitage material or even tools. They show only one or two characteristics of a flake, a blade, or a certain tool. Because they do not have all the characteristics, or because the observed characteristics are vague, an interpretation as possible piece of debitage / tool is justified. They are thus not categorised as undefined fragments, neither as debitage material, because such a distinction cannot be made with certainty.
- **Pendant**: ornament of which the perforation is not located in the centre but at an extremity.
- **Unfinished pendant**: ornament with the start of a perforation.
- **Bead**: ornament of which the perforation is located centrally.
- **Others**: these are artefacts or tools which may be described as "unexpected finds", and are therefore not included in the typological list nor in the previous artefact types.

1.1.4 Elucidation of tool description
Every tool in this study is described in detail (Special characteristic's box). For a thorough and comparative analysis a systematic method is chosen. The following variables are recorded: blank, shape, cross section, location of the surfaces, fragmentation, stone type, degree of burning, dimensions, weight, location of the working areas, orientation of the working areas in relation to one another, and visible traces of debitage or reuse. Some of these variables are already registered during the typological analysis of the artefact and are simply copied.

The orientation of the artefact is determined by the location of the worked area and/or the form of the artefact. If the worked area is located in the middle of a surface, this surface is placed upwards. If the worked area is located at an extremity of the object, the form is decisive. For example: a grinding stone, an anvil or a semi-finished pendant is placed with the grinding area, the worked surface or the unfinished perforation facing upward. If two surfaces are worked, the form of the artefacts is decisive and the artefact is placed in the most stable position, often meaning that the largest areas are facing upwards and downwards, hence the definition as 'surface' (see below). For hammerstones the form is decisive, as the worked areas are located on the extremities or rims.

When the orientation is ascertained, the different areas can be designated and the artefact can be described. The area facing upwards and downwards are called 'surfaces', the areas facing to the left, right, front and back are called 'sides'. The shape of the artefact is its form viewed from above. The cross section is the form of the plane of fracture if the artefact would be cut in half from above. Then the orientation of the surfaces is registered which defines the overall form of the artefact, for example two opposing surfaces or a flat surface opposing a tip. Fragmentation, degree of burning, dimensions and weight is already noted down during the typological analysis. The stone type is also copied and studied in more detail.

1.2 Definitions used for flint artefact analysis

1.2.1 Definition of primary classification
As mentioned in chapter 3 (section 3.1.2), the primary classification is the subdivision between artefacts smaller than 1 cm (< 1 cm) and those equal or larger than 1 cm (≥ 1 cm). The artefacts are measured according the debitage axis and divided correspondingly. It is obvious that the group of artefacts ≥ 1 cm has a diverse type composition but the group of < 1 cm shows a large variety of types as well. They can be very small, undamaged flakes and blades (chips or microchips) or fragments thereof. They can also be fragments without a clear dorsal or ventral face which gives them the characteristics of undefined fragments. Only when pieces < 1 cm show clear characteristics of certain artefact types other than debitage material or waste material, they are treated as such and transferred to the group of artefacts ≥ 1 cm. This is the case for microburins, tool fragments and such. In that case, typology is

more important than size. The artefacts ≥ 1 cm are studied in detail and are subject to typological and technological analyses.

1.2.2 Definition of variables

Artefacts ≥ 1 cm
For the artefacts ≥ 1 cm the following variables are registered:

- Main artefact type
- Subtype
- Flint type
- Degree of burning
- Weathering
- Type of blank
- Fragmentation
- Dimensions
- Weight
- Refitting possibilities
- Special characteristics

Table 1.9 Main artefact type

1	Flake
2	Blade
3	Preparation / rejuvenation material
4	Core
5	Indeterminate fragment
6	Frost flake
7	Potlid
8	Burin spall
9	Micro-burin
10	Tool on flake
11	Tool on blade
12	Tool on preparation / rejuvenation material
13	Scraper
14	Borer / reamer
15	Burin
16	Combination tool
17	Other tools
18	Microlith with one point
19	Microlith with two points
20	Triangles
21	Hybrids
22	Steep retouches blades
23	Arrowhead with surface retouch
24	Trapeze
25	Transverse arrowhead
26	Retouched chips
27	Artefact with visible use-wear traces
28	Nodule
29	Indeterminate tool
30	Indeterminate tool fragment
31	Bipolar piece
32	Other

– Main artefact type and subtype: the type of artefact based on a typological list.

Specific artefact types are grouped in artefact categories. The debitage material comprises flakes (1), blades (2), rejuvenation pieces (3), cores (4), burin spalls (8), and micro-burins (9). The group of tools (10 – 26, 29, 30) is self-evident, whereas the artefacts with visible use-wear traces (27) and the bipolar pieces (31) form a separate group each. The waste material combines undefined fragments (5), frost flakes (6), potlids (7), and nodules (28). The last group is defined as "other" (32) and combines special finds not included in the typological list.

Table 1.10 Subtype.

1	Flake intact
2	Fragment of a flake
3	Blade intact
4	Proximal fragment of a blade
5	Proximal and medial fragment of a blade
6	Medial fragment of a blade
7	Medial and distal fragment of a blade
8	Distal fragment of a blade
9	Lateral fragment of a blade
10	Fragment of a blade with combined fractures
11	Core preparation piece / crested piece
12	Platform rejuvenation pieces
13	Striking edge rejuvenation piece
14	Core tablet
15	Production plane rejuvenation piece
16	Core with one striking platform
17	Core with two opposing striking platforms
18	Core with two crosswise striking platforms
19	Core with multiple striking platforms
20	Core with centripetal striking platforms
21	Bipolar core
22	Nodule with starting debitage
23	Proximal micro-burin
24	Distal micro-burin
25	Micro-burin opposing fracture
26	Krukowski micro-burin
27	Micro-burin on tool
28	Double micro-burin
29	Retouched flake
30	Denticulated flake
31	Carved flake
32	Truncated flake
33	Retouched blade / backed blade
34	Denticulated blade
35	Carved blade
36	Truncated blade
37	Blade broken above notch
38	Blade broken in notch
39	Retouched core rejuvenation piece
40	Denticulated core rejuvenation piece
41	Carved core rejuvenation piece
42	Truncated core rejuvenation piece

Table 1.10 continued

43	Retouched indeterminate fragment
44	Retouched burin spall
45	Retouched core
46	Single scraper
47	Single scraper (retouched edges)
48	Double scraper
49	Double scraper (retouched edges)
50	Round scraper / oval scraper
51	Core scraper
52	Side scraper
53	Borer (indistinct / bec)
54	Borer
55	Borer with alternate retouches (ruimer)
56	Simple axis burin / A burin
57	Dihedral axis burin / AA burin
58	Burin on truncation / RA burin
59	Burin on fracture
60	Multiple burin
61	Burin / bec
62	Zinken
63	Scraper / burin
64	Scraper / borer
65	Burin / borer
66	Rounded piece
67	Splintered piece
68	A point
69	B point
70	C point with dorsal base
71	C point with ventral base
72	C point with bifacial base
73	D point
74	Zonhoven point
75	Needle shaped point
76	Trapezoid point
77	Rhomb shaped point
78	Segment
79	Lancette point
80	Scalene triangle
81	Isosceles triangle
82	Triangle with three retouched edges
83	Hybrid segment / triangle
84	Hybrid C point / lancette point
85	Rounded oblique truncation
86	Other hybrids
87	Small backed bladelet
88	Small backed bladelet with truncation
89	Small backed bladelet with two truncations
90	Small double backed bladelet with truncation
91	Small double backed bladelet with two truncations
92	Small triangular backed bladelet
93	Symmetric trapeze
94	Asymmetric trapeze
95	Rectangular trapeze
96	Rhombic trapeze
97	Indeterminate tool type
98	Indeterminate tool fragment
99	Not applicable

– Type of blank: the type of blank used to produce the artefact.

Table 1.11 Type of blank.

1	Flake
2	Blade
3	Fragment of flake / blade
4	Preparation / rejuvenation
5	Core
6	Debris
7	Frost flake / potlid
8	Nodule
9	Indeterminate
10	Other

– Fragmentation: the degree of completeness of the artefact, i.e. which part remains.

Table 1.12 Fragmentation.

1	Intact
2	Broken indeterminate
3	Proximal fragment
4	Proximal / medial fragment
5	Medial fragment
6	Medial / distal fragment
7	Distal fragment
8	Broken laterally
9	Combined fracture
10	Damaged

Table 1.13 Damaged.

1	Proximal
2	Medial
3	Distal
4	Proximal and distal

An artefact is damaged when only a very small piece is missing, an artefact is broken when a large part is missing. If only a very small fragment of the artefact is missing it is registered as intact in the 'Fragmentation' field but in the secondary field 'Damaged' the location of the minor damage is given. When it cannot be determined which part is still remaining, by the lack of any ripples or other indication of debitage axis, the term 'Broken undefined' is chosen. A 'Combined fracture' is the occurrence of a transverse and a lateral fracture. No technical information on the type of fracture is registered.

- Weathering: the type of weathered surface or natural surface[1] still present on the artefact and the coverage on the dorsal surface or any other of the surfaces for that matter.

Table 1.14 Type of cortex.

1	Fresh chalky cortex
2	Weathered cortex
3	Rolled cortex
4	Pseudo-cortex: Hertzian cones

Table 1.15 Type of patina.

1	Colour (anterior)
2	Gloss (anterior)
3	Windblown gloss (anterior)
4	Colour and gloss (anterior)
5	Colour and windblown gloss (anterior)
6	Colour (posterior)
7	Gloss (posterior)
8	Colour and gloss (posterior)
9	Other
10	Indeterminate

Two types of weathering are discerned. The first type is physical weathering which results in the eroding of the cortex or the nodule's surface. This type of weathering is often the result of transportation from primary outcrops to secondary positions. This action leaves physical traces such as the deterioration of the chalky cortex, but also internal fissures, cones of fracture or Hertzian cones, and surface scratches. Frost fissures are a type of physical weathering as well. Fresh chalky cortex, weathered chalky cortex, rolled or shiny cortex, and pseudo-cortex are the four successive stages of physical weathering in cortex and surface erosion.

On flake scars or when chalk is fully eroded from a surface, a second type of weathering can occur. This is a chemical weathering resulting in patina. This type of weathering and other environmental processes, like wind, can interact with the surface of the material, resulting in several anterior or posterior patinas of different colours, with or without (windblown) gloss.

For each type of weathering, the surface coverage is noted. In order to keep track of combined coverage, when an artefact is showing both cortex and patina, a total of surface weathering is noted down as well.

Table 1.16 Surface coverage in %.

1	None
2	1 - 25 %
3	25 - 50 %
4	50 - 75 %
5	75 - 100 %
6	100%
7	Fragment with old surface

- Flint type: the type of flint used to produce the artefact.

Table 1.17 Flint type.

1	Fine-grained with bryozoans
2	Medium-grained with bryozoans
3	Coarse-grained with bryozoans
4	Fine-grained without bryozoans
5	Medium-grained without bryozoans
6	Coarse-grained without bryozoans
7	Type Rijckholt
8	Light-grey Belgian
9	Valkenburg
10	Rüllen
11	Lousberg
12	Simpelveld
13	Zevenwegen
14	Indeterminate

One of the most important distinctions within flint research of the Swifterbant culture, or any other culture for that matter, is the use of exotic raw material. In order to differentiate between local and foreign flint the presence of bryozoans is important. These bryozoans are a type of fossil typical for northern flint. Southern flint might have inclusions but of a different type. Therefore, this classification based on the presence or absence of these bryozoans has a central place in this research. It should be mentioned that not all northern flint is characterised by bryozoans.

The second aspect of the analysis is the coarseness of the flint. Flint can be fine-, medium- or coarse-grained. Although flint is amorphous, it is not always homogeneous. It can be specked, mottled or 'cloudy', banded, or can even have coarser-grained inclusions. These inclusions can be misleading during definitions when the artefact is rather small and largely consists of such an inclusion. Furthermore, flint can vary from being translucent to being opaque and can have a wide variety of colours, from yellowish to brown, from greyish to black.

Some flint types have been linked to certain outcrops and were named after them (types 7-13). The attribution of an artefact to a certain outcrop is not always easy to accomplish. Therefore, more general descriptions (1-6) are provided. Often material from secondary locations

1 In Dutch this surface, i.e. cortex or patina is sometimes referred to as 'old surface'.

cannot be traced to its origin. Also, the artefact needs to be big enough to have a positive and definite determination.

Alteration by fire hinders a good visual recognition of the flint type. Often heavily burned artefacts are no longer identifiable by raw material.

– Degree of burning: the degree of heat exposure.

Table 1.18 Degree of burning.

1	Not burned
2	Lightly burned
3	Moderately burned
4	Heavily burned

In this research only traces visible to the naked eye are registered. The degree of burning is determined by the damage or discolouration visible on the artefact. Three degrees of burning are defined. The characteristics of light heat exposure are internal fractures with our without reddish discolouration. Moderate heat exposure results in internal fractures combined with potlids. Depending on the temperature of the fire the flint might discolour to different shades of grey (Sergant et al 2006). Heavily burnt flint objects show internal fractures, potlids, and white discolouration. Heat exposure can also result in the presence of gloss (Price et al 1982, Rottländer 1989, Sergant et al 2006).

By the time of moderate exposure and grey discolouration, the type of flint can no longer be defined. The presence of inclusions is mostly still visible but they can no longer be distinguished from one another. Coarseness is after burning only in very rare cases discernible, by example when the artefact is very coarse-grained. It must also be noted that in some cases when flint artefacts are discoloured by heat exposure they can no longer be distinguished from particular sorts of quartzite when these are discoloured by heat as well.

It has been observed that often the colour on the inside of an artefact is whiter than that of the surface. Might this imply that the heat on the inside of the artefact was more intense or that it lasted longer than on the surface once the fire was extinguished?

Every so often the surface of an object is black, and not light-grey or whitish, while the inside is coloured light-grey to white. This is definitely the result of burning because potlidding occurs but an extra factor may be involved as well for this black discolouration is a characteristic not found on all burned flint artefacts. This factor might be some sort of surface alteration such as patina or dehydration. It is not a post-depositional process like discolouration as the effect of soil minerals, for example black discolouration in peaty soils, because the potlidded area does not show any black discolouration.

– Dimensions: the measurements of the artefact, in millimetres (measurements are rounded off to the nearest whole millimetre).

Table 1.19 Dimensions.

1	Length
2	Width
3	Thickness

The measuring of the dimensions of an artefact is determined by the orientation of that artefact. The orientation of an artefact is in its turn determined by the type of that artefact. Flakes and blades are oriented according their debitage axis; this axis is the length. Width is measured transversely to that and thickness is measured perpendicular to that. If the bulb of percussion is the thickest part of the artefact this is regarded as the accurate thickness because the bulb is considered to be fully part of the artefact. Cores are measured in the same way as flakes and blades but along the debitage axis of their main striking platform.

Tools are oriented according their working surface or retouched edge and not their debitage axis. All measurements are taken accordingly.

Other artefact types such as undefined fragments, potlids, frost flakes, and nodules have no precise orientation. These are measured by their morphology. The longest dimension is considered to be the length; the other dimensions are measured transverse and perpendicular to that. The second longest dimension is considered to be the width and the smallest is the thickness.

– Weight: the weight of the flint artefacts are measured to a hundredth of a gram precise.
– Refit possibilities: when two or more artefacts can be refitted, this is noted down in this field, along with the corresponding artefacts numbers.
– Special characteristics: any special characteristics an artefact might have are registered here. These can be tool descriptions, special features or other general remarks.

Artefacts < 1 cm
For the artefacts < 1 cm the following variables are registered:
- Number of artefacts per find number
- Degree of burning
- Total weight
- Special characteristics

– Number: this variable is only used in the category artefacts < 1 cm. It is possible that more than one artefact is retrieved on a certain spot or from a certain square,

but only given one find number. They are treated as a whole and not described separately.
- Degree of burning: the total amount of artefacts < 1 cm is checked on degree of burning and placed within one of the four categories: not burned, lightly burned, moderately burned, and heavily burned. Their number is given per category.
- Total weight: this variable is only used in the category artefacts < 1 cm. It is possible that more then one artefact is retrieved on a certain spot or from a certain square. They are treated as a whole and not weighed separately.
- Special characteristics: any special characteristics an artefact or group of artefacts might have are registered here. These can be special features or other general remarks.

1.2.3 Definition of terminology

Debitage and tool terminology are based on Crabtree (1972), Inizan (et al. 1999) and Tixier (1974).

- **Flake**: a general term for a fragment of flint that is removed from

  a) a core during its preparation (preparation flake, preliminary flake, decortication flake, etc.)

  b) a cobble, a slab, a core, etc., and if need be fashioned into a tool at a later stage (knapping flake, debitage flake)

  c) a tool during manufacture (retouch flake, shaping flake).

  Flakes are measured according debitage axis. Some flake fragments are labelled as "possible blade fragment" in the Special characteristics box of the database when their edges and ridges are parallel combined with the general impression of the artefact.

  Although Inizan (et al., 1999) use the terms edge and aris in relation to detachments, the choice is made to use the terms defined by Tixier (1974) for they are more wide spread. These are edge and ridge.

  Decortication flakes are flakes covered from 75% up to 100% with old surface like cortex or patina.

  This category from the main artefact type list combines the subtypes 1-2.
- **Blade**: a blade is a flake of which the length is at least equal to twice its width; a bladelet is a small blade. The limit between a blade and a bladelet is determined by length, which can vary per scholar, however in this research no difference has been made. The distinction, if ever one is needed, can be deduced from the length. Several authors and researchers make a distinction between true (regular) blades and blade-like flakes, a true blade showing traces of previous parallel removals on its dorsal face, and also having more or less parallel edges. In this study flakes and blades are determined by their length-width ratio. When blades can be characterised as regular a note was made in the "Special characteristics" box.

  This category from the main artefact type list combines the subtypes 3-10.
- **Preparation / rejuvenation material**: rejuvenation material: a core tablet, flake or blade which is the result of the preparation or rejuvenation of the core before or during debitage, which may become necessary when the condition of the striking platform precludes the debitage from being continued.

  This category from the main artefact type list combines the subtypes 11-15.
- **Core**: a block of raw material from which flakes, blades, or bladelets have been struck, in an systematic fashion in order to produce blanks for tools.

  This category from the main artefact type list combines the subtypes 16-20, and 22. Subtype 21 is relocated to main type 31 (bipolar pieces).
- **Indeterminate fragment**: this term should only be used to denote pieces of stone (artefacts) whose mode of fracture or debitage axis cannot be identified and which cannot be designated as any other type of artefact.
- **Frost flake**: a fragment of an artefact detached as the result of frost.
- **Potlid**: a fragment of an artefact detached as the result of heat exposure.
- **Burin spall**: part of a blank that has been detached by the burin blow technique. Unretouched, it presents all the characteristics of a flake or a blade.
- **Microburin**: waste product or residue, not intended for function, as a result of severing blades to make microliths; usually the proximal or distal end of a blade.

  This category from the main artefact type list combines the subtypes 23-28.
- **Tool on flake or blade**: a flake which is structured, sculpted, and intentionally transformed by a removal or a series of specific removals carried out for the purpose of obtaining a tool.

  This category from the main artefact type list combines the subtypes 29-32
- **Tool on blade**: a blade or bladelet which is structured, sculpted, and intentionally transformed by a removal or a series of specific removals carried out for the purpose of obtaining a tool.

  This category from the main artefact type list combines the subtypes 33-38.
- T**ool on preparation / rejuvenation material**: a preparation / rejuvenation piece which is structured, sculpted, and intentionally transformed by a removal or a series of specific removals carried out for the purpose of obtaining a tool.

  This category from the main artefact type list combines the subtypes 39-45.
- **Scraper**: a tool with a regularly retouched scraper front.

This category from the main artefact type list combines the subtypes 46-52.
- **Borer**: two retouches edges forming a point at one end. These edges may be retouched dorsally or ventrally.
  This category from the main artefact type list combines the subtypes 53-55.
- **Burin**: a chisel-like implement derived from a flake or blade; or the modification of other implements by using the burin technique to remove the edges parallel to their long axis and/or transversely or obliquely.
  This category from the main artefact type list combines the subtypes 56-62.
- **Combination tool**: a tool combining characteristics of two different tool types.
  This category from the main artefact type list combines the subtypes 63-65.
- **Other tools**: this category from the main artefact type list combines the subtypes 66 and 67.
- **Microlith with one point**: this category from the main artefact type list combines the subtypes 68-74.
- **Microlith with two points**: this category from the main artefact type list combines the subtypes 75-79.
- **Triangles**: this category from the main artefact type list combines the subtypes 80-82.
- **Hybrids**: a transitional form between two different microlith types.
  This category from the main artefact type list combines the subtypes 83-86.
- **Backed blades**: tools on blade with intentional dulling of at least one edge of the blank.
  This category from the main artefact type list combines the subtypes 87-92.
- **Arrowhead with surface retouch**: arrowhead types with invasive or covering retouch.
- **Trapeze**: trapeze shape arrowhead[2] with a length-width ratio of less than 1. Length is measured along the debitage axis. Because of this the width of a trapeze is comparable to the width of blank blades.
  This category from the main artefact type list combines the subtypes 93-96.
- **Transverse arrowhead**: trapeze shape arrowhead with a length-width ratio of 1 or more.
- **Chip with retouch**: little fragments (< 1 cm) of tools or tool's edges.
- **Artefact with visible use-wear traces**: artefacts, such as flakes or blades, with traces of use visible to the naked eye. These can present themselves as sheen, polish or gloss or little use-retouches, i.e. small, often irregular retouches that are chipped off from an unretouched side possibly during use. However, trampling may cause the same type of irregular retouches.
- **Nodule**: piece of raw material.
- **Indeterminate tool**: tools that cannot be defined as any of the above mentioned tool types.
- **Indeterminate tool fragment**: these artefacts are retouched pieces, or fragments of tools, that are too badly broken and thus no longer recognizable as a certain tool type.
- **Bipolar piece**: an artefact produced with the bipolar technique.
- **Other**: these are more or less unexpected finds and are therefore not in the typological list nor included in the previous categories.

1.3 Other definitions used in lithic analysis

Residential or domestic versus special activity
In this research, when a site is characterised as residential, or domestic for that matter, the same principle is implied, i.e. that the range of activities is wide and represents the activities one would associate with a settlement. For example the occurrence of hammer stones, anvils, grinding stones, and combination tools used for a wide range of activities such as food processing, hide working, temper production, flint knapping, and so on. For the flint industry this would be the combination of scrapers, retouched pieces, borers, arrowheads, and bipolar pieces with large amounts of debitage material all used for daily activities such as hide processing, plant processing, butchering, tool making, and so on. Thus, a residential or domestic character stands in contrast to that of a special activity site, or even a ritual character, that is represented by a small spectrum of tools. It does not reflect upon the time depth of the occupation, or whether the site is permanently inhabited or not.

2 Although the word trapeze refers to a short bar hanging by two ropes which acrobats use (as in flying trapeze), and trapezium is used in mathematical contexts (as in trapezoid), the choice was made to use the term trapeze for it is commonly used in archaeological contexts.

Appendix 2

Variables and definitions of attribute analysis

2.1. Definitions used for attribute analysis

2.1.1 Introduction

As mentioned in chapter 5 (section 5.6.2), the technological analysis is based on several attributes. In the following section these will be further specified. First, attributes to analyse the general morphology of the flakes and blades will be discussed, afterwards the attributes to analyse the specific characteristics of the butts will be addressed.

2.1.2 Morphology of flakes and blades

For this analysis the following attributes are registered:

- Longitudinal curvature
- Type of detachment
- Delineation of the lateral edges
- Type of cross-section
- Number of dorsal ridges
- Dorsal ridge pattern
- Type of proximal termination
- Type of distal termination

– Longitudinal curvature

Table 2.1 Longitudinal curvature.

1	Straight
2	Concave
3	Distal
4	Convex
5	Torque
6	Not applicable (fragment)
7	Other

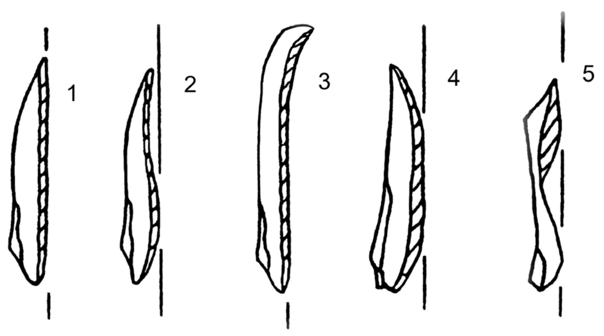

Figure 2.1 Different types of longitudinal curvature. Adapted from Nishiaki 2000, fig. 3.11.

– Type of detachment

Table 2.2 Type of detachment.

1	Along axis
2	To the left
3	To the right
4	Not applicable (fragment)

– Delineation of the lateral edges

Table 2.3 Delineation of the lateral edges.

1	Divergent
2	Convergent
3	Parallel (sub)
4	Divergent - convergent
5	Retouched
6	Irregular
7	Not applicable (fragment)

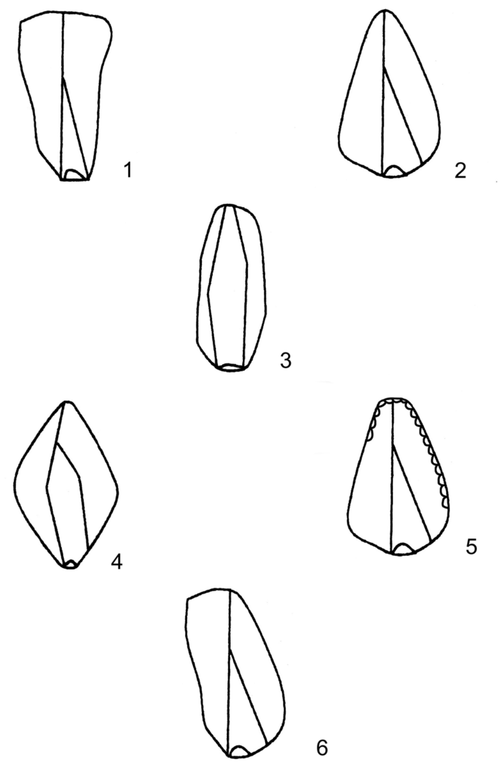

Figure 2.2 Different delineations of lateral edges. Adapted from Shen 2001, fig. 5.10.

– Type of cross-section

Table 2.4 Type of cross-section

1	Triangular symmetrical
2	Triangular asymmetrical
3	Rectangular
4	Trapezoid
5	Lenticular
6	Irregular
7	Not applicable (fragment)

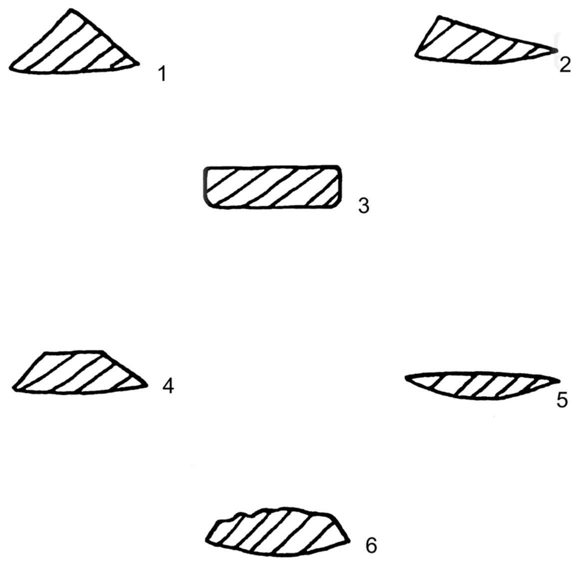

Figure 2.3 Different types of cross-section. Adapted from Nishiaki 2000, fig. 3.10.

– Number of dorsal ridges

This is a number to be inserted, between 0 and 6, plus 99 for "not applicable". In the text, and its tables, the following division is used:

Table 2.5 Number of dorsal ridges.

	0
	1
	2
	3
	4 or more
	Not applicable

– Dorsal ridge pattern

This is a number to be inserted, between 111 and 133, based on the schematic below. In the text, and its tables, the following division is used:

Table 2.6 Dorsal ridge pattern.

	Straight
	Half turn
	Quarter turn
	Quarter + half turn
	Not applicable

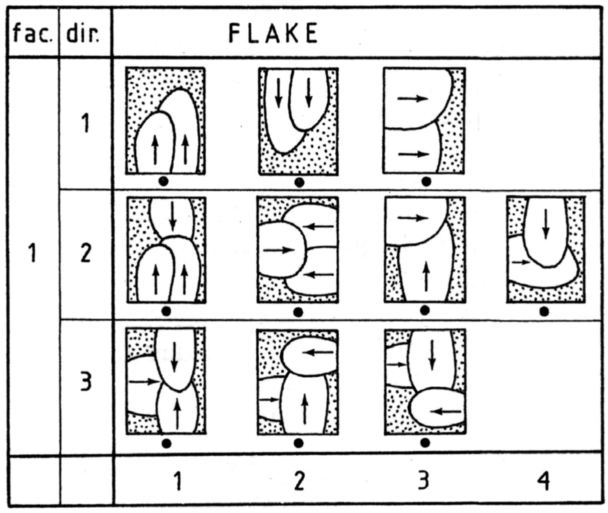

Figure 2.4 Different dorsal ridge patterns. Adapted from Peeters 2001a, bijlage 1, fig. 2.

– Type of proximal termination

Table 2.7 Type of proximal termination.

1	Butt
2	Damaged
3	Step
4	Retroflexed
5	Hinge
6	Retouched
7	Splintered
8	Irregular
9	Potlid
10	Not applicable

– Type of distal termination

Table 2.8 Type of distal termination

1	Feather
2	Step
3	Retroflexed
4	Hinge
5	Plunged
6	Splintered
7	Straight
8	Impact point
9	Potlid
10	Retouched
11	Irregular
12	Not applicable

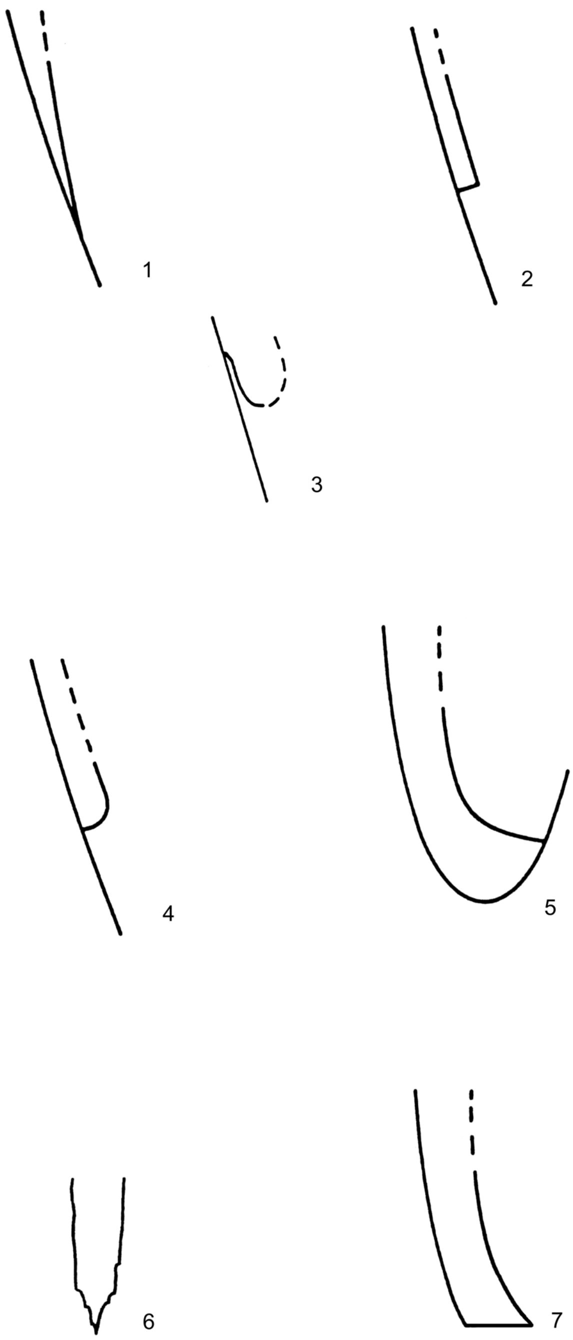

Figure 2.5 Different types of distal termination. Adapted from Cotterell & Kamminga 1990, fig. 6.8.

2.1.3 Morphology of butts and bulbs of percussion

For this analysis the following attributes are registered:

- Shape of the butt (view from above and side-view)
- Dimensions of the butt
- Type of preparation of the butt
- Shape of the bulb
- Angle of the bulb
- Impact angle of flakes and blades

– Shape of the butt:

To determine the shape of the butt, the view from above is combined with the side-view resulting in a compound number of type.

Table 2.9 Shape of butt (view from above).

1	Linear
2	Punctiform
3	Horseshoe
4	Triangular ("saddle roof")
5	Trapezoid
6	W-shaped ("gendarme")
7	Crescent
8	Asymmetrical ("winged")
9	Irregular

Table 2.10 Shape of butt (side-view).

1	Plain
2	Concave
3	Light convex
4	Strong convex
5	Irregular
6	Spur ("en éperon")

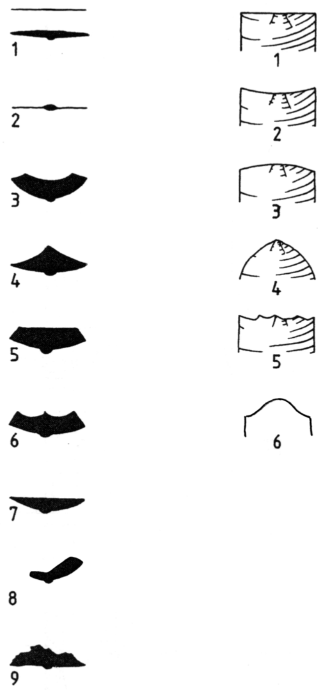

Figure 2.6 Different shapes of the butt. Adapted from Peeters 2001a, appendix 1, fig. 3.

– Dimensions of the butt:

These dimensions are measured in mm according the following plan: the thickness of the butt is the distance measured from the dorsal face to the ventral face while the width is the distance measured from one lateral edge to the other.

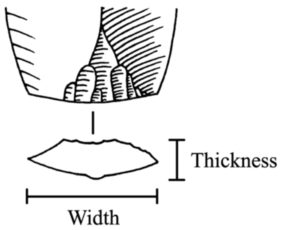

Figure 2.7 Schematic representation of the butt. Adapted from Peeters 2001a, appendix 1, fig. 3.

– Type of preparation of the butt:

Table 2.11 Preparation of butt.

1	Plain
2	Dihedral
3	Facetted
4	Natural surface (patina)
5	Cortical
6	Polished
7	Crushed
8	Linear / straight
9	Punctiform
10	Not applicable

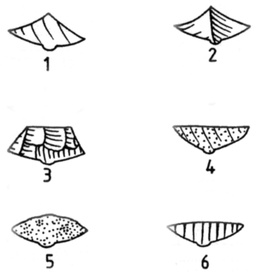

Figure 2.8 Different types of preparation of the butt. Adapted from Peeters 2001a, appendix 1, fig. 3.

– Shape of the bulb:

Table 2.12 Shape of bulb.

1	Strongly pronounced
2	Lip
3	Splintered
4	Lightly pronounced
5	Straight
6	Concave
7	Angular / Hertzian cone

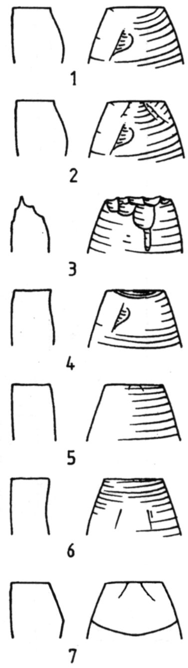

Figure 2.9 Different shapes of the bulb. Adapted from Peeters 2001a, appendix 1, fig. 3.

– Angle of the bulb:

The development or angle of the bulb is measured per 10° and is formed by the angle between the butt and the bulb.

Figure 2.10 Schematic representation of the angle of the bulb. Adapted from Peeters 2001a, appendix 1, fig. 3.

– Impact angle of flakes and blades:

The impact angle is measured per 10° and is formed by the angle between the butt and the line running from the impact point to the distal end of the flake or blade.

Figure 2.11 Schematic representation of the impact angle of flakes and blades. Adapted from Peeters 2001a, appendix 1, fig. 3.

2.1.4 Morphology of cores

For this analysis the following attributes are registered:

- Shape of core
- Type of detachments
- Type of striking platform
- Position of production plane
- Type of core sides
- Pattern of production plane
- Reason of discard

– Shape of the core:

Table 2.13 Shape of core.

1	Prismatic
2	Pyramid-shaped
3	Sphere
4	Irregular
5	Nodule
6	Lenticular
7	Other
8	Not applicable (fragment)

– Type of detachments:

Table 2.14 Type of detachments.

1	Blades / Bladelets
2	Flakes
3	Combination
4	Not applicable (fragment)

–

– Type of striking platform:

Table 2.15 Type of striking platform.

1	Cortical
2	Natural surface (patina)
3	Plain
4	Dihedral
5	Facetted
6	Combination
7	Old production plane
8	Linear striking edge
9	Not applicable (fragment)

– Position production plane:

Table 2.16 Position production plane.

1	Front
2	Front and one side
3	Front and two sides
4	Front and back
5	All the way round
6	Not applicable (fragment)

– Type of core sides:

Table 2.17 Type of core sides.

1	Cortical / natural surface
2	Retouch
3	Part of production plane
4	Combination
5	None (lenticular)
6	Not applicable (fragment)

– Pattern of production plane:

This is a number to be inserted, between 111 and 333, based on the schematic below. In the text, and its tables, the following division is used:

Table 2.18 Pattern of production plane.

Core with one striking platform
Core with two opposing striking platforms
Core with two crossed striking platforms
Core with multiple striking platforms
Core fragment

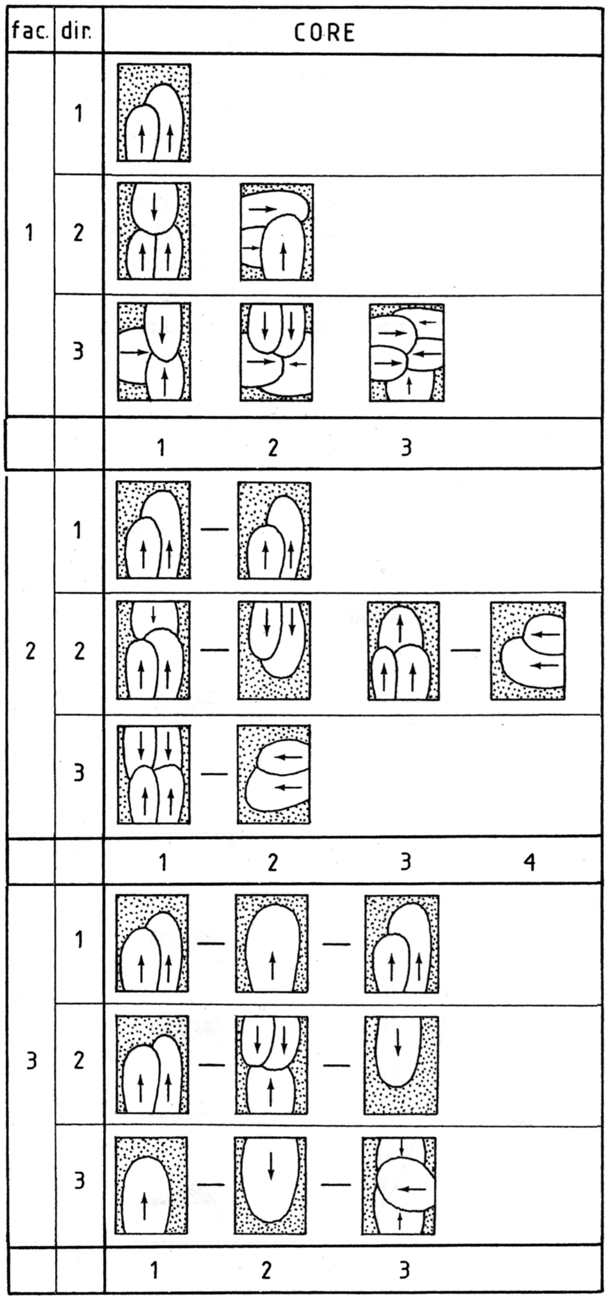

Figure 2.12 Different patterns of production plane. Adapted from Peeters 2001a, appendix 1, fig. 3.

– Reason of discard:

Table 2.19 Reason of discard.

1	Size
2	Impurities
3	Debitage mistakes
4	Angle
5	Combination
6	Not applicable

Appendix 3

Additional information

3.1. Additional artefacts from the larger Swifterbant area

3.1.1 Stone finds from the larger Swifterbant area

Parcel K20

To be complete, I would also like to mention the only stone find available for parcel K20, a field just east of the village Swifterbant at c. 2.5 km southeast of parcel H46 and 5.3 km southeast of parcel G43. The stone fragment is an artefact < 3 g, weighing 0.3 g. Even with the three flint finds (see below), it is impossible to determine whether these finds are of a natural origin or man-made. Because there is no exact information about the precise location of the finds, the circumstances in which they were recovered or the stratigraphical build-up of the site itself, only further research at the location itself can bring clarity on this matter.

3.1.2 Flint finds from the larger Swifterbant area

Section H

In the past three flint artefacts were recovered from somewhere in section H. Unfortunately, it was never registered on which parcel exactly they were discovered and thus to what possible site they belong to. According to the little information available on the finds note the material was found some parcels north of parcel H46. On the note parcel G34 is mentioned with a question mark. It is unclear who found the artefacts and it is also unclear who made the suggestion of parcel G34. It remains undecided where exactly the artefacts originate from but it is very unlikely to be parcel G34 as it is not located north of parcel H46. Both sites S11-S13 and S71 are a more likely candidate and even sites S80-S84 cannot be ruled out.

The three artefacts are all blades, one intact and two fragments. All three are made of fine-grained flint without bryozoans and do not have any cortex or patina. One is detached obliquely and another has sub-parallel edges and two converging ridges. Minimum and maximum measurements are 17x7x1 mm and 40x12x4 mm.

Sand depot at Kamperhoek

In 1965, seven artefacts were found in a sand depot[3]. The note accompanying the artefacts mentions a “sand depot along the dike Ketelhaven – Lelystad at hectometre 25/7 (Kamperhoek?)”.

The finds consist of two flakes, three intact blades, a blade fragment and a frost flake. All artefacts are made of fine-grained flint, mostly with bryozoans. Two artefacts have small remnants of weathered cortex and anterior glossy patina. The flakes are rather large and massive measuring 26x47x9 mm and 35x32x11 mm. The first shows three Hertzian cones on its irregular ventral face. One of the blades is massive as well measuring 63x31x8 mm, the others measure between 28x7x4 mm and 42x15x5 mm. The frost flake is rather thick, 23x18x9 mm and possibly has a few retouches on one end. Noteworthy is that all seven artefacts are very different from one another. Besides the blade fragment, that has a somewhat fresh appearance, the artefacts are covered with posterior gloss. Yet they are all lightly damaged on the edges. This is probably the result of post-depositional processes as well as recent transportation.

Parcel K20

On this parcel, at c. 2.5 km southeast of trenches S21-S24, only three flint artefacts and one stone artefact are available (see above). The flint artefacts can be defined as one indeterminate flint fragment and two frost flakes. The low number and the nature of the finds itself, make it hard to determine whether these finds are signs of human activity or not. One might assume that the flint finds are indeed artefacts and not mere ecofacts because on none of the other parcels in the area flint or stone occurs naturally. Therefore, it is presumed that the artefacts were taken to the location. The complete lack of any information about this site or the find circumstances and its isolated location, make it impossible to clarify or resolve this matter any further. Still, even though the parcel is located outside the Swifterbant area, the presence of these finds might indicate the presence of a site location.

3 The find is registered as Z 1965 / I. The find numbers are 154-155 and 233-237.

3.2. Meta data

Nearly all of the stone and flint material has been inputted to a Microsoft Access database. In order to keep track of the different excavations campaigns, or excavations techniques, sites have sometimes been nominated differently. For example, the material from sites S2 and S51 are divided in S2, S2*, S51, and S51*. This * is a mnemonic inserted to facilitate working with the vast amounts of artefacts. In no way it indicates a difference between the material from one or the other datasheet. The same accounts for the artefacts from trenches S21-S24. The many different field campaigns, excavated by different research facilities with diverse techniques, in combination with the somewhat careless numbering or packing of the artefacts, resulted in six different datasheets (also see tables below).

3.3. Tables

Stone assemblages

Table 3.1 Number of stone artefacts and other information per excavation campaign at site S2.

	Number	Unburnt	Burnt	Weight (g)	Numeration	Site
≥ 3 g						
G42	98	96	2	7,546.3	zak 1 - zak 2 - zak 3	G42
1975-1979						
Hand collected	287	259	28	11,194.6	nos. 0007 - 8538	S2
Hand collected (grave)	8	8		2.7	*0001 - *0008	S2
Sieved (numbered)	5	5		0.5	nos. with 900000	S2
Sieved (not numbered)	116	108	8	267.4	nos. with Z	S2
2004						
GIA	16	16		59.0	nos. with G89	S2
Subtotal	***530***	***492***	***38***	***19,070.5***		
< 3 g						
G42	30			40.4	zak 2 - zak 3	G42
1975-1979						
Hand collected	137			176.6	nos. 0033 - 8357	S2
Sieved	5			2.8	nos. with 900000	S2
Sieved unk. origin	2113			578.7	nos. with Z	S2
2004						
GIA	340			48.1	nos. with G89	S2
Subtotal	***2625***			***846.6***		
Total	**3155**	**492**	**38**	**19,917.1**		

The white finds bags are designated with "zak 1 - 3".

Table 3.2 Number of stone artefacts and other nformation per excavation method and trenches at site S3.

	Number	Unburnt	Burnt	Weight (g)	Numeration	Site
≥ 3 g						
Site S3						
Hand collected	1736	1557	179	99,321.5	nos. 00021 - 57660	S3
Unknown origin	5	3	2	2,532.8	nos. with *	
Sieved	116	101	15	7,596.8	nos. with 900000	S3
Sieved unknown origin	12	12		3.2	nos. with 980000	S3
Sieved in bulk	308	307	1	1,231.3	nos. with Z	S3
Trench S5						
Hand collected	19	17	2	2,552.4	nos. S5	S5
Trench S6						
Unknown origin	1	1		0.1	nos. with 700000	S6
Unknown origin	47	42	5	1,959.0	nos. with 800000	S6
Sieved in bulk	11	11		14.4	nos. with Z	S6
Subtotal	***2255***	***2051***	***204***	***115,211.5***		
< 3 g						
Site S3						
Hand collected	1417			1,633.8	nos. 00043 - 57921	S3
Sieved	85			41.3	nos. with 900000	S3
Sieved unknown origin	19			10.2	nos. with 980000	S3
Sieved in bulk	6983			2,639.4	nos. with Z	S3
Trench S6						
Unknown origin	26			35.5	nos. with 800000	S6
Sieved in bulk	33			17.7	nos. with Z	S6
Subtotal	***8563***			***4,377.9***		
Total	**10818**	**2051**	**204**	**119,589.4**		

Table 3.3 Number of stone artefacts and other information per excavation campaign at site S4.

	Number	Unburnt	Burnt	Weight (g)	Numeration	Site
≥ 3 g						
1974						
Hand collected	110	107	3	2,946.3	nos. 00021 - 2009	S4
Sieved unk. origin	5	5		5.2	nos. with Z	S4
2005-2007	442	425	17	26,895.9	nos. with G92	S4 / S4 (2)
Subtotal	***557***	***537***	***20***	***29,847.4***		
< 3 g						
1974						
Hand collected	63			68.0	nos. 0010 - 1981	S4
Sieved unk. origin	38			12.4	nos. with Z	S4
2005-2007	17745			2,051.6	nos. with G92	S4 / S4 (2)
Subtotal	***17846***			***2,132.0***		
Total	**18403**	**537**	**20**	**31,979.4**		

Table 3.4 Number of stone artefacts and other information per excavation trench at trenches S21-S24.

	Number	Unburnt	Burnt	Weight (g)	Numeration	Site
≥ 3 g						
S21						
Unknown origin	102	102		1,683.2	nos. 041 - 262	S…
Grave A	5	5		13.9	nos. *003 - *008	S21
WP 3B	5	3	2	30.8	nos. *909 - *933	S21
H46 Kavelsloot Noord *	13	13		1,548.0	zak 5	S21?
H46 Kavelsloot Noord *	1	1		50.0	no. *06	S21?
H46 Kavelsloot Zuid *	88	84	4	2,335.4	zak 7	S21?
H46 Kavelsloot Zuid *	2	2		450.2	nos. *14 - *15	S21?
S22						
Unknown origin	6	6		74.1	nos. 027 - 236	S…
Unknown origin	1	1		382.5	no. *001	S22
Loose finds	4	3	1	514.7	nos. 154 - 2787	S22
WP 6C	1	1		17.0	*001	S…
H46 Bermsloot Oost	93	91	2	2,310.8	zak 6	S22?
H46 Bermsloot Oost	6	6		548.9	nos. *08 - *013	S22?
H46 Bermsloot West	33	29	4	2,224.1	zak 4	S22?
H46 Bermsloot Oost + West	25	25		766.1	zak 8	S22?
S23						
Unknown origin	20	19	1	1,008.6	nos. 0004 - 1849	S23
Unknown origin	7	7		84.0	nos. *001 - *003	S23
H46						
Unknown origin	63	60	3	1,667.1	nos. 263 - 914	S…
Subtotal	***475***	***458***	***17***	***15,709.4***		
< 3 g						
S21						
Unknown origin	206			211.6	nos. 036 - 262	S…
Loose finds	3			3.6	nos. 28 - 34	S21
Grave A	17			6.2	nos. *001 - *008	S21
WP 3B	1			0.1	no. *912	S21
H46 Kavelsloot Noord *	10			11.0	zak 5	S21?
H46 Kavelsloot Zuid *	74			99.6	zak 7	S21?
S22						
Unknown origin	25			33.4	nos. 001 - 256	S…
Loose finds	4			2.1	nos. 054 - 475	
WP 6C						
H46 Bermsloot Oost	114			146.3	zak 6	S22?
H46 Bermsloot West	30			46.3	zak 4	S22?
H46 Bermsloot Oost + West	26			34.3	zak 8	S22?
S23						
Unknown origin	37			6.9	nos. 0002 - 2067	S23
Unknown origin	10			8.8	nos. *001 - *003	S23
H46						
Unknown origin	33			32.1	nos. 263 - 862	S…
Subtotal	***590***			***642.3***		
Total	**1065**	**458**	**17**	**16,351.7**		

The white finds bags are designated with “zak 4 - 8”.

Table 3.5 Number of stone artefacts and other information per excavation method at site S51.

	Number	Unburnt	Burnt	Weight (g)	Numeration	Site
≥ 3 g						
Hand collected	37	34	3	4,050.2	nos. 1016 - 1915	S51
Sieved	12	12		12.1	nos. with Z	S51
Unknown origin	2	2		839.7	*01 - *02	S51
Subtotal	***51***	***48***	***3***	***4,902.0***		
< 3 g						
Hand collected	14			14.7	nos. 1060 - 2763	S51
Sieved	227			47.7	nos. with Z	S51
Subtotal	***241***			***62.4***		
Total	**292**	**48**	**3**	**4,964.4**		

Table 3.6 Number of stone artefacts and other information per excavation method at site S61.

	Number	Unburnt	Burnt	Weight (g)	Numeration	Site
≥ 3 g						
Hand collected	10	10		1,940.0	nos. 005 - 311	S61
Unknown origin	3	2	1	797.6	nos. with *	S61
Sieved	2	2		0.4	nos. with 900000	S61
Sieved in bulk	3	3		4.5	nos. with Z	S61
Subtotal	***18***	***17***	***1***	***2,742.5***		
< 3 g						
Hand collected	8			3.1	nos. 017 - 516	S61
Sieved	2			0.2	nos. with 900000	S61
Sieved in bulk	2536			93.7	nos. with Z	S61
Subtotal	***2546***			***97.0***		
Total	**2564**	**17**	**1**	**2,839.5**		

Flint assemblages

Table 3.7 Number of flint artefacts and other information per excavation campaign at site S2.

	Number	Unburned	Burned	Weight (g)	Numeration	Site
≥ 1 cm						
Ditch slope	1		1	18.60	bag 1	S2
1961/1964-1971						
vd Heide	129	83	46	355.29	nos. 60000 - 60130	S2*
1975-1979						
Hand collected	353	186	167	1,204.99	nos. 0004 - 8535	S2
Unknown layer	29	27	2	257.92	nos. 190000 - 190028	S2*
Sieved	497	228	269	380.89	nos. with 900000	S2*
Unknown origin	3	1	2	2.06	*001 - *003	S2*
Sieved unk. origin	6	2	4	4.86	nos. with Z	S2*
2004						
GIA	11	3	8	6.64	nos. with G89	S2
Subtotal	***1029***	***530***	***498***	***2,231.25***		
< 1 cm						
1961/1964-1971						
vd Heide	3	2	1	1.10	nos. 60125 - 60131	S2*
1975-1979						
Hand collected	10	1	9	3.50	nos. 0197 - 8245	S2
Sieved	312	122	190	41.74	nos. with 900000	S2*
Sieved unk. origin	20	5	15	2.02	nos. with Z	S2*
2004						
GIA	14	5	9	0.60	nos. with G89	S2
Subtotal	***359***	***135***	***224***	***48.96***		
Total	**1388**	**665**	**722**	**2,280.21**		

Table 3.8 Number of flint artefacts and other information per excavation method and trenches at site S3.

	Number	Unburnt	Burnt	Weight (g)	Numeration	Site
≥ 1 cm						
S3						
Hand collected	7918	5539	2379	19,126.78	nos. 00001 - 57864 or *	S3
Sieved	6137	4269	1868	4,897.02	nos. with 900000	S3
Sieved unknown origin	1854	1202	652	1,254.62	nos. with 980000	S3
Sieved unknown origin	111	65	46	81.28	nos. with Z	S3
Trench S5						
Hand collected	40	26	14	87.52	nos. 002 - 203 or S5	trench S5
Trench S6						
Hand collected	26	19	7	75.73	nos. 000189 - 000802	trench S6
Unknown origin	48	34	14	35.76	nos. with 700000	trench S6
Unknown origin	34	26	8	140.52	nos. with 800000	trench S6
Site S6						
Hand collected	3	3		13.23	nos. 01 - 03	G43/G44
Subtotal	***16171***	***11183***	***4988***	***25,712.46***		
< 1 cm						
S3						
Hand collected	648	406	242	159.72	nos. 00038 - 57923	S3
Sieved	6249	4585	1664	738.18	nos. with 900000	S3
Sieved unknown origin	2084	1392	692	253.69	nos. with 980000	S3
Sieved unknown origin	187	121	66	20.53	nos. with Z	S3
S6						
Unknown origin	24	18	6	3.79	nos. with 700000	trench S6
Unknown origin	2	2	0	0.23	nos. with 800000	trench S6
Subtotal	***9194***	***6524***	***2670***	***1,176.14***		
Total	**25365**	**17707**	**7658**	**26,888.60**		

Table 3.9 Number of flint artefacts and other information per excavation campaign at site S4.

≥ 1 cm	Number	Unburnt	Burnt	Weight (g)	Numeration	Site
1974						
Hand collected	176	94	82	244.02	nos. 0001 - 2042	S4
Sieved	32	17	15	17.04	nos. with 900000	S4
2005-2007	1276	766	510	2,398.46	nos. with G92	S4 and S4*
Subtotal	***1484***	***877***	***607***	***2,659.52***		
< 1 cm						
1974						
Hand collected	11	5	6	1.93	nos. 0051 - 1814	S4
Sieved	23	12	11	3.38	nos. with 900000	S4
2005-2007	2184	1560	624	110.65	nos. with G92	S4 and S4*
Subtotal	***2218***	***1577***	***641***	***115.96***		
Totaal	**3702**	**2454**	**1248**	**2,775.48**		

Table 3.10 Number of flint artefacts and other information per excavation trench at trenches S21-S24.

	Number	Unburnt	Burnt	Weight (g)	Numeration	Site
≥ 1 cm Sample						
S21						
Grave A	236	155	81	289.26	nos. 001 - 236	S21
S21 - ZA	184	134	50	729.33	nos. 001 - 184	S21
S22						
H46 Bermsloot Oost	21	13	8	168.05	nos. *01 - *023	S22
H46 Bermsloot West	50	44	6	355.62	nos. 045 - 955	S22
S23						
S23 (dune sand)	806	392	414	811.89	nos. 0001 - 2575	S23
S23 Erosion layer	788	438	350	547.78	nos. 0001 - 0790	S23
≥ 1 cm Other						
H46 Kavelsloot Noord *	315	219	96	918.90	Finds bags A & B	S21
H46 Kavelsloot Zuid *	1578	853	725	5,598.20	Finds bags C, D & E	S21
H46 Bermsloot Oost *	3411	2305	1106	8,414.80	Finds bags F, G, J & L	S22
H46 Bermsloot West *	1027	723	304	2,068.50	Finds bags H & I	S22
H46 Lager op helling *	13	13		31.80	Finds bag K	S22
H46 Loose finds	19	19		48.78		
S21 (various bags: 1971-73)	2926	-	-	9,955.10**		S21
S22 (various bags: 1971-73)	305	-	-			S22
H46 Unknown origin: 1971-73	1162	-	-	4,068.30**		S21-S22
H46 Unknown origin: 1971-73 ?	136			281.00**		S21-S22 ?
S21 (various bags: 1976)	307	-	-	-		S21
S22 (various bags: 1976)	1064	-	-	-		S22
S23 (various bags: 1976)	1797	-	-	-		S23
Unknown origin: 1976	22	-	-	-		S21-S24
Subtotal	***16167***	***5308***	***3140***	***34,287.31***		
< 1 cm Sample						
S21						
Grave A	247	155	92	23.26	nos. 01 - 247	S21
S21 - ZA	7	3	4	1.21	nos. 01 - 07	S21
S22						
H46 Bermsloot Oost	2	1	1	0.43	nos. *21 - *22	S22
S23						
S23 (dune sand)	653	222	431	104.69	nos. 0007 - 2937	S23
S23 Erosion layer	655	271	384	96.30	nos. 001 - 655	S23
< 1 cm Other						
S21 (various bags: 1971-73)	247	-	-	-		S21
S22 (various bags: 1971-73)	21	-	-	-		S22
H46 Unknown origin: 1971-73	153	-	-	-		S21-S22
H46 Unknown origin: 1971-73 ?	790					S21-S22 ?
S21 (various bags: 1976)	24	-	-	-		S21
S22 (various bags: 1976)	113	-	-	-		S22
S23 (various bags: 1976)	229	-	-	-		S23
Unknown origin: 1976	3	-	-	-		S21-S24
Subtotal	***3144***	***652***	***912***	***225.89***		
Total	**19311**	**5960**	**4052**	**34,513.20**		

* The material from these 17 finds bags is only counted and may contain between c. 600 and 1300 artefacten < 1 cm.

** Weight in bulk.

Table 3.11 Number of flint artefacts and other information per parcel at site S41.

	Number	Unburnt	Burnt	Weight (g)	Numeration	Site
≥ 1 cm						
G39	15	9	6	49.26	nos. 01 - 15	S41
G44	42	23	19	366.93	nos. 01 - 42	S41
Subtotal	***57***					
< 1 cm						
G39	1	0	1	0.23	no. 16	S41
S41	1	0	1	0.15	no. 1	S41
Subtotal	***2***					
Total	**59**	**32**	**27**	**416.57**		

Table 3.12 Number of flint artefacts and other information per excavation method at site S51.

	Number	Unburnt	Burnt	Weight (g)	Numeration	Site
≥ 1 cm						
Hand collected	69	49	20	163.03	nos. 1036 - 2865	S51
Sieved	71	48	23	54.15	nos. with 900000	S51*
Sieved Unknown origin	12	8	4	11.29	nos. with 990000	S51*
Subtotal	***152***	***105***	***47***	***228.47***		
< 1 cm						
Hand collected	6	4	2	1.88	nos. 1055 - 2802	S51
Sieved	55	23	32	4.86	nos. with 900000	S51*
Sieved Unknown origin	4	2	2	0.36	nos. with 990000	S51*
Subtotal	***65***	***29***	***36***	***7.10***		
Total	**217**	**134**	**83**	**235.57**		

Table 3.13 Number of flint artefacts and other information per excavation method at site S61.

≥ 1 cm	Number	Unburnt	Burnt	Weight (g)	Numeration	Site
Hand collected	493	410	83	1,828.67	nos. 008 - 950	S61
Sieved	291	247	44	164.01	nos. with 900000	S61*
Sieved Unknown origin	10	6	4	5.05	nos. with Z	S61*
Subtotal	***794***	***663***	***131***	***1,997.73***		
< 1 cm						
Hand collected	143	112	31	26.31	nos. 010 - 937	S61
Sieved	850	697	153	57.82	nos. with 900000	S61*
Sieved Unknown origin	50	33	17	2.03	nos. with Z	S61*
Subtotal	***1043***	***842***	***201***	***86.16***		
Total	**1837**	**1505**	**332**	**2,083.89**		

Table 3.14 Number of flint artefacts and other information per excavation method and sites at sites S81-S84.

	Number	Unburnt	Burnt	Weight (g)	Numeration	Site
≥ 1 cm						
Hand collected						
S80	81	66	15	627.49	nos. 15 - 38	S80
S81	13	12	1	86.87	nos. *01 - *13	S81
S82	77	54	23	139.65	nos. 001 - 106	S82
Subtotal	***171***	***132***	***39***	***854.01***		
< 1 cm						
Hand collected						
S80	2	2		0.82	nos. 15 - 38	S80
Sieved						
S82	60	23	37	5.55	nos. 001 - 106	S82
Subtotal	***62***	***25***	***37***	***6.37***		
Total	**233**	**157**	**76**	**860.38**		

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